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4.5 SURFACE WATER AND SEDIMENTS

This section provides an assessment of the nature and extent of EMF-related constituents in surface water, sediments, and springs associated with the river. The assessment is based on the results of the surface water and sediment sampling performed as part of the RI. The sampling and analysis program for the surface water and sediment investigation was described in Section 2.4 of this report.

Phase I consisted of sampling at locations ranging from the City of Pocatello, approximately 6 miles (9.6 km) upstream of the EMF facilities, to River Mile 10, approximately 4 miles (6.4 km) downstream of the EMF facilities (Figures 4.5-1 and 4.5-1a to g). Water samples were collected from 27 locations during four events: July 1992, October 1992, February 1993, and April 1993; sediments were collected in July 1992. Flow gaging in the Portneuf River was performed at selected locations during these sampling events. Samples collected at nine of the 27 locations were spring samples as opposed to river water samples, and thus reflected groundwater chemistry. The springs included Batiste and Swanson Road Springs also sampled as part of the groundwater monitoring program discussed in Section 4.4.

Phase II consisted of surface water and sediment sampling at locations in the immediate vicinity of the FMC IWW ditch outfall (Figure 4.5-1h) and sediment sampling in the Fort Hall Bottoms (approximately 5.5 miles [8.8 km] downstream from the EMF facilities) (Figure 4.5-1i). All Phase I and II samples were analyzed for a suite of metals, nutrients, common ions, fluoride and radiological parameters.

Because the EMF facilities have been in operation for more than 40 years, it was assumed that cumulative effects of chemicals transported to the river from the EMF facilities would be evident in sediments collected along the Portneuf River near the EMF facilities. When measureable impact on sediment proved limited to the immediate area of the FMC IWW ditch outfall, and there was no measurable impact on surface water, another investigation was initiated at EPA's request at the confluence of the Portneuf River and the American Falls Reservoir. Results of this investigation are presented in Section 4.6, Ecology.

Surface Water and Sediment Investigation Objectives

The objectives of the surface water and sediment investigation were:

- To assess the nature and extent of any EMF-related impacts on the Portneuf River water and sediments.
- To evaluate the pathways by which chemicals originating from the EMF facilities may be transported to the river. The four potential pathways are:
 - Direct aerial deposition,
 - Surface runoff from impacted surface soils,
 - Discharge of impacted groundwater
 - Direct discharge (i.e., the IWW ditch outfall)

Overview of Findings

The major findings of the surface water and sediment investigation are listed below. Data evaluation methods used to arrive at these findings included comparisons of upstream and downstream results; comparison of results with soil and groundwater representative levels; and application of various statistical techniques, including cluster analyses, t-tests, and non-parametric ANOVAs.

- There were no measureable effects on surface water chemistry directly attributable to the EMF facilities. Surface water upstream from the EMF facilities contained lower sulfate, nitrate, and total phosphorus concentrations than river water downstream of the facilities; however, this result is explained by the high rate of groundwater unaffected by the EMF facilities discharging to the river (200 cfs between the EMF facilities and Siphon Road). In addition, there are other documented sources of nitrate, sulfate, and total phosphorus to the Portneuf River downstream from the EMF facilities.
- EMF effects on sediments were limited to samples SD17 and SD17A, collected at the IWW ditch outfall.
- Because there were no measurable effects on sediment chemistry attributable to the EMF facilities beyond the localized area of the IWW ditch outfall, aerial deposition and surface soil runoff are not significant transport pathways to surface water and sediment. This

conclusion is further supported by results for specific samples most likely to reflect the influences of these pathways (sediment samples SD9 and SD11).

- Consistent with Section 4.4 findings, groundwater discharging at Batiste and Swanson Road Springs contained EMF-related constituents. Arsenic, barium, boron, and lithium, and ammonia, nitrate, total phosphorus, and sulfate exceeded representative groundwater levels in one or more samples from these springs. However, the average concentrations of these chemicals at these springs were not significantly above representative groundwater levels. In fact, average concentrations of arsenic and nitrate were below representative groundwater levels. None of these constituents were identified at elevated levels in samples collected immediately downstream of Batiste or Swanson Road Spring.
- Constituent concentrations were not elevated in river water at the IWW ditch outfall. (A comparison of data for groundwater from FMC production well FMC-1, the source of the non-contact cooling water discharged to the IWW ditch; water from the IWW ditch; and surface water collected at the IWW ditch outfall is presented in Tables 4.5-1 and 4.5-1a).

Section Content and Organization

An overview of the organization and conclusions of Section 4.5 is provided on Figure 4.5-2. The results, data evaluation methods, and findings of the surface water investigation are presented in Section 4.5.1. Section 4.5.2 presents the results, data evaluation methods, and findings for sediment.

RI surface water and sediment sampling results are presented in Appendix U.

<p>CHARACTERIZATION OF SURFACE WATER (SECTION 4.5.1)</p>	<p>Overall Discussion (Section 4.5.1.1)</p> <ul style="list-style-type: none"> • There do not appear to be any representative level exceedances downstream directly attributable to the EMF facilities despite above-representative levels of EMF-related constituents detected at Batiste and Swanson Road Springs. 	<p>Statistical Methods (Section 4.5.1.2)</p> <ul style="list-style-type: none"> • The springs can be divided into groups based on spring water chemistry. Batiste and Swanson Road Spring chemistry are unique. • The general chemistry of the groundwater discharging to the river is different from that of the upstream river water. As expected, downstream river water is more similar to groundwater than to the upstream water under low-flow conditions. • Mixing zone effects were generally not apparent downstream of the EMF facilities. 	<p>Detailed Discussion (Section 4.5.1.3)</p> <ul style="list-style-type: none"> • This section provides a chemical-by-chemical comparison of down-stream river water with groundwater and upstream river water.
<p>CHARACTERIZATION OF SEDIMENTS (SECTION 4.5.2)</p>	<p>Overall Discussion (Section 4.5.2.1)</p> <ul style="list-style-type: none"> • The only sediment samples which reflect EMF influences are SD17 and SD17A collected at the FMC IWW outfall. • Above-representative level constituent concentrations were not detected in downstream samples 	<p>Statistical Methods (Section 4.5.2.2)</p> <ul style="list-style-type: none"> • With few exceptions, near-site, spring and downstream sediment constituent concentrations were not statistically different from upstream concentrations. Constituents for which statistical differences were found were often higher upstream from the EMF facilities than they were downstream. • Samples from the IWW outfall (SD17 and SD17A) were very different from all other samples, underscoring the conclusion that SD17 reflects IWW ditch influence and that measurable effects of this influence are localized at the outfall. 	<p>Detailed Discussion (Section 4.5.2.3, River Sediments and Section 4.5.2.4, Spring Sediments)</p> <ul style="list-style-type: none"> • Upstream sediment constituent concentrations were very similar to soil representative levels. • These sections provide a sample-by-sample discussion of the river and spring sediment sample analytical data. • Aerial deposition and surface water runoff do not appear to be significant transport pathways as evidenced by the results for sediment samples SD9 and SD11.

FIGURE 4.5-2
OVERVIEW OF SURFACE WATER AND SEDIMENT INVESTIGATION

4.5.1 NATURE AND EXTENT OF EMF-RELATED CONSTITUENTS IN SURFACE WATER

The nature and extent of EMF-related constituents in surface water were investigated by two methods. The first was a multivariate statistical method called cluster analysis. This was performed to assess the degree of dissimilarity of samples collected beyond the potential influence of the EMF facilities with those collected downstream. The second was a chemical-by-chemical comparison of constituent concentrations with representative groundwater concentrations and upstream surface water concentrations. During low-flow conditions along the Portneuf River, the comparison of downstream surface water samples with groundwater representative levels is valid due to the relatively large volume of groundwater discharged to the river downstream from the EMF facilities. Three sampling events occurred during low-flow conditions (less than one-half average flow), and one event occurred during above-average flow conditions. For the purposes of this investigation, gaining reach river water quality was compared to background groundwater chemistries as defined in Section 4.4, since groundwater from all three hydrogeochemical regimes discharges to the river.

The results of these comparisons and analyses were used along with the understanding of surface water hydrology presented in Section 3.3 and knowledge of EMF and non-EMF potential sources to draw conclusions as to the nature and extent of EMF effects on surface water.

4.5.1.1 Surface Water Chemistry Data – Overall Results

The following discussion of surface water chemistry within the EMF study area draws on the data summarized in Tables 4.5-2 through 4.5-8. Appendix U presents metals analysis results with validation qualifiers for individual samples collected during each round of RI sampling.

Antimony, beryllium, cadmium, chromium, cobalt, lead, molybdenum, nickel, selenium, silver, thallium, and zinc were either not detected in any of the water samples or were detected only in concentrations at their detection limits. These constituents are not discussed further in this section. Mercury was reported by the laboratory to be present in several surface water samples at

levels just above its detection level. However, these results are considered to be false-positives as discussed in Section 4.1.

Total aluminum, iron, and manganese were detected above representative groundwater levels at a number of locations. However, their concentrations correlate well with turbidity and river discharge, and are thus likely indicative of naturally occurring suspended solids in the river system. Nevertheless, these elements are also discussed in Section 4.5.1.3.

Arsenic, ammonia, barium, boron, fluoride, lithium, nitrate, phosphorus, and sulfate were found at concentrations above representative groundwater levels at Batiste Spring (SW14) and Swanson Road Spring (SW15). Although some of these chemicals exceeded representative groundwater levels in one or more downstream samples, the exceedances do not appear to be attributable to EMF. A detailed discussion of the above-listed constituents is provided in Section 4.5.1.3.

Copper was detected at mean concentrations in excess of the representative groundwater concentrations at the IWW ditch outfall (0.015 mg/l total copper), but these levels did not exceed the mean concentrations for upstream sampling station SW19.

4.5.1.2 Surface Water Statistical Analyses – Methods and Results

Data presented in Tables 4.5-2 through 4.5-7 are mean concentrations of analytes. The mean concentrations at each sampling station were calculated using results from four samples collected over a one year period, when available. Constituents reported as not detected were not used in the calculation of mean concentrations. Omission of the nondetects when calculating mean concentrations is considered a conservative approach because it typically leads to higher mean concentrations for comparison with the representative groundwater concentrations, which were calculated using the detection limit values. This approach exaggerates surface water concentrations with respect to groundwater concentrations.

A multivariate statistical analysis called cluster analysis was used to investigate the possibility that surface water samples collected within the channel of the Portneuf River were within the "mixing zone" of nearby discharges (e.g., STP), and thus were not representative of ambient Portneuf River (Park, 1974). Cluster analysis was also used to investigate groupings or clusters within the dataset that are not immediately evident by inspection. Cluster analysis is used for investigating patterns in datasets using multiple variables concurrently.

For this analysis, constituents displaying the highest degree of dissimilarity were used. These were: calcium, arsenic, barium, bicarbonate, fluoride, potassium, lithium, magnesium, sodium, ammonia, nitrate, orthophosphate, total phosphorus, and sulfate. This group of constituents includes those transported via various pathways. Use of these variables increased the overall contrast between samples or sample "clusters".

The cluster analysis confirmed that certain springs form distinct groups. Samples SW13 (STP), SW9 (FMC Employee Park), SW15 (Swanson Road Spring), and SW14 (Batiste Spring) all define separate clusters, indicating unique chemistry associated with each spring. Springs located further north (SW2, SW5, SW7, SW6, and SW4) are similar to each other and dissimilar from the other springs. SW9 is more similar to the northern springs, and less similar to the springs near the EMF facilities and the STP.

This analysis also indicates that spring chemistry is distinct from the river chemistry, regardless of season or river discharge. Samples from SW11, in the spring drainage downstream of Batiste Spring, are more similar to river samples than the Batiste Spring samples. In other words, EMF-related influences detected at Batiste Spring are no longer apparent in the surface water along the spring drainage several hundred feet downstream. This finding is not unexpected, because the drainage channel from Batiste Spring triples in flow rate between the spring house (SW14) and the point at which it meets the main river channel, providing ample water to dilute the EMF-influenced water discharged at Batiste Spring.

For some sampling events, SW11 is more similar to SW10 or SW12, both downstream river sampling points. This indicates that the gaining river water is more similar to representative groundwater than the upstream river water. This finding is expected because the river gains more than 200 cfs from groundwater discharge, and during low-flow conditions, upstream river flow is only 20 to 150 cfs. In general, samples from unaffected springs are similar to the gaining reach river water during low flow events. This provides further support to the conclusion that gaining reach river water is more similar to groundwater chemistry than it is to upstream surface water chemistry. These results mean that, under low-flow conditions, comparing downstream surface water chemistry with background groundwater chemistry is a valid means of assessing potential EMF-related influences on surface water quality in the river.

Samples from the upstream river reach form four distinct groups, one for each sampling event. This clustering indicates that the upstream water chemistry is fairly consistent throughout the losing river reach, up to station SW16. SW17, near the FMC IWW ditch outfall, is not similar to any other river or spring samples, but the SW17 samples are not similar to one another, indicating temporal variation. The sample collected during April 1993 at SW25, furthest upstream from the EMF facilities, is markedly different from samples collected further downstream. This difference indicates there may have been a point source impact at SW25 during this sampling event, but there is not a measurable impact further downstream.

The April 1993 results are unique along the entire river reach in that the upstream samples (excluding SW25) and downstream samples are more similar to each other than the upstream versus downstream samples from low river discharge sampling events. This is expected because the river had very high flows during the April 1993 sampling event, and any influences from groundwater along the gaining reach will be lessened by high river flow associated with regional surface water runoff from snow melt and spring rains.

Mixing Zone Effects. The cluster analysis supports the conclusion (1) that certain sample locations were subject to mixing zone effects, and (2) that mixing zone effects were not prevalent throughout the year nor were these effects dominant in the overall sample network. To

illustrate, one prediction is that the water samples collected at a location influenced by "mixing zone effects" would be similar to the point discharge water chemistry, and unlike the upstream river water. Another prediction is that the water collected from a mixing zone should have a distinct water chemistry, especially if the point discharge water chemistry is distinctly different from river water chemistry. However, such predictions were not borne out by the data except under low flow conditions at one sampling location (SW5).

During low flow periods, there appears to have been a "mixing zone effect" observed at SW5, located in the river channel downstream from the Papoose Springs Fish Farm. During low flow periods, SW5 samples were more similar to the Papoose Spring samples SW7 and SW6. During high river flow in April 1993, SW5 was more similar to river stations SW1 and SW3A. These results indicate that SW5 is more representative of the Papoose Spring water than river water during low flow conditions. However, during higher flow, SW5 is more representative of river water. Mixing zone effects were not as obvious at SW10, located downstream from the outfall of Batiste Springs, or at SW12, at the STP outfall. In fact, SW10 was not similar to either Batiste Spring sampling location SW11 and SW14, but in several instances, the SW10 samples were most closely linked to SW12, near the STP outfall. This pattern indicates, that if there is a water chemistry signature from the STP discharge, it is observable at SW10.

Mixing zone effects were only observed at SW5 under low flow conditions in the river; the constituents discharging from Papoose Spring and influencing SW5 under these conditions are not associated with the EMF facility. It was demonstrated in Section 3.3 that groundwater from the EMF facilities does not flow toward Papoose Spring. With these preceding exceptions, the samples collected within the Portneuf River are, consequently, not biased by influences from nearby point source discharges. Thus, they adequately document ambient water quality within the river at the time of sampling.

4.5.1.3 Surface Water – Detailed Discussion

A detailed discussion of the surface water sampling results with particular focus on those constituents that exceeded upstream mean concentrations or the representative groundwater

concentrations is provided below. The discussion provides additional support for conclusions presented in Sections 4.5.1.1 and 4.5.1.2 about the nature and extent of EMF-related constituents in surface water.

This section focuses on the constituents detected at elevated concentrations in Batiste Spring and Swanson Road Spring (i.e., those constituents known to be transported from the EMF source areas to surface waters). These constituents include ammonia, arsenic, barium, boron, fluoride, nitrate, lithium, total phosphorus, and sulfate. Copper was detected above groundwater representative levels at the IWW ditch outfall sampling point in the river, and is included in the detailed discussion of river sampling results. Vanadium is discussed because results from the July 1992 sampling event appear to be affected by laboratory or field artifacts, not because vanadium was detected at elevated concentrations in the groundwater pathway or the IWW ditch discharge. Aluminum, iron, and manganese in the river samples are also discussed, although these constituents correlate with turbidity and river discharge and are not believed to be associated with the EMF facilities.

Metals

Arsenic in Springs. Arsenic was detected in at least two rounds of sampling for all spring and spring-drainage sampling points. Highest mean arsenic concentrations were at Batiste Spring (0.032 mg/l dissolved) and Swanson Road Spring (0.010 mg/l dissolved) (Table 4.5-2). These mean concentrations were higher than or equal to the representative concentrations for groundwater related to the discharges at Batiste Spring and Swanson Road Spring (0.018 mg/l Bannock Range regime associated with Batiste Spring, and 0.0104 mg/l Portneuf River Valley regime associated with Swanson Road Spring). The highest mean arsenic concentrations for the East Side System and Papoose System springs and spring-drainage sampling points were below representative groundwater levels.

The maximum arsenic concentration at Swanson Road Spring (0.0134 mg/l dissolved) occurred during the October 1992 sampling event. The maximum arsenic concentrations for Batiste

Spring (0.057 mg/l dissolved; 0.032 mg/l total) occurred during the April 1993 sampling event. However, the dissolved arsenic concentration is questionable and likely biased-high because it was greater than the total arsenic concentration.

At sampling point SW11, arsenic was detected during only two events. The maximum concentration (0.008 mg/l total) was detected during April 1993.

Arsenic in River. Arsenic concentrations in river water were low compared with concentrations in representative groundwater (Table 4.5-3). Arsenic was detected in at least two rounds of sampling for all river sampling stations except SW16 (and SW18, which was only sampled once). Mean total arsenic concentrations were marginally higher in the losing-reach group of river sampling stations (0.006 mg/l) than in the gaining-reach group (0.004 mg/l). Highest individual station means were found in the four losing-reach stations, SW20 through SW18 plus SW16. These four river sampling stations, along with SW17, are nearest to and downstream of the EMF facilities. However, the means calculated for these sampling points are based on two samples rather than the four taken. The two samples not used were below detection limits or rejected in the validation process. If mean concentrations were calculated using all four samples, the mean arsenic concentrations would have been considerably lower at these four sampling stations. In the gaining reach, arsenic concentrations in river water were comparable to concentrations in representative groundwater.

Barium in Springs. Barium concentrations in springs were comparable to representative groundwater levels. Barium was detected routinely in samples from spring and spring-drainage sampling points. The mean barium concentrations ranged from 0.064 to 0.123 mg/l, which are less than the representative groundwater levels for all sampling points except Twenty Springs-East (SW02). The mean total barium concentration at Twenty Springs-East is 0.760 mg/l. This mean concentration may have been artificially high because of a single measurement (2.81 mg/l during July 1992). Using only subsequent sampling data to calculate the mean total barium

concentration for SW02 yields a value of 0.077 mg/l. This lower mean concentration is consistent with mean concentrations for other springs.

Barium in River. Barium was detected routinely in samples from all river sampling stations. However, all mean barium concentrations were below the representative levels for groundwater (0.12 mg/l, Bannock Range; and 0.17 mg/l, Portneuf River Valley). The widespread distribution of this parameter suggests that barium is naturally occurring in river water.

Boron in Springs. Boron was detected in at least two rounds of sampling for all spring and spring-drainage sampling points. Highest mean boron concentrations were at SW15, Swanson Road Spring (0.28 mg/l total and 0.21 mg/l dissolved), and SW13, the springs near the STP (0.24 mg/l total and 0.22 mg/l dissolved). However, these concentrations are near or below the representative groundwater levels for the Portneuf River Valley hydrogeochemical regime (0.25 mg/l). In addition, Batiste Spring (SW14), Batiste Springs drainage (SW11), and Papoose Spring (SW07) also had mean boron concentrations below representative levels (0.308 mg/l, Bannock Range). Since boron was found in all four spring groups at similar levels and only two springs discharge groundwater affected by EMF-related activities, the boron was most likely naturally occurring at the levels noted above.

Boron in River. Boron was detected in at least two rounds of sampling at all river sampling stations. The highest mean boron concentrations were detected in the Phase I samples at SW17 (0.38 mg/l total and 0.23 mg/l dissolved) (Table 4.5-1). At sampling stations SW25, SW24, SW23, SW19, SW16, SW12, and SW10 mean total boron concentrations ranged from 0.27 to 0.33 mg/l, compared with the representative levels for groundwater of 0.31 mg/l for Bannock Range and 0.25 mg/l for Portneuf River Valley (Table 4.5-3). The maximum boron concentration detected during subsequent sampling was 0.11 mg/l. In general, the boron detected in the river samples was not elevated downstream from EMF discharges.

Copper in River. Mean copper concentrations in Table 4.5-3 typically represent one or two samples at each station in which copper was reported. As discussed in Section 4.4, the groundwater pathway is not transporting copper to surface waters, nor is copper an EMF-related constituent at source areas.

For river sampling station SW17 at the FMC IWW ditch outfall, mean Phase I copper concentrations (0.015 mg/l total and 0.011 mg/l dissolved) were approximately two times the mean concentration for all river samples (0.007 mg/l) for both total and dissolved copper. The Phase II sampling data at SW17 had a mean copper concentration of 0.007 mg/l, with values ranging from ND to 0.011 mg/l. The Phase I SW17 results indicate that the IWW ditch was transporting groundwater containing representative levels of copper. Additionally, there was a higher copper concentration detected at an upstream station (0.022 mg/l at SW19), indicating copper concentrations in surface are variable.

Lithium in Springs. Lithium was detected in at least three rounds of sampling of all spring and spring-drainage sampling points. The highest mean lithium concentrations were at SW14, Batiste Spring (0.051 mg/l total and 0.053 mg/l dissolved; Table 4.5-2). These concentrations were above the representative level for Bannock Range groundwater (0.0165 mg/l).

Lithium concentrations for the Papoose Spring system (SW05, SW06, SW07) ranged from not detected to 0.038 mg/l (total) and from 0.024 to 0.039 mg/l (dissolved), greater than the representative level for Bannock Range groundwater (0.0165 mg/l), but less than the Michaud Flats and Portneuf River Valley representative levels (0.040 and 0.061 mg/l). Mean lithium concentrations for Swanson Road Spring (SW15) and East Side springs (SW09 and SW13) ranged from 0.023 to 0.044 mg/l, and were comparable to the representative level (0.040 mg/l) for Portneuf River Valley representative groundwater.

Lithium levels were higher in river water upstream of the EMF operations areas (SW23 to SW25) than in springs (Tables 4.5-2 and 4.5-3). Figure 4.5-5 illustrates this trend in lithium concentrations for spring sampling points and for river sampling stations.

Lithium concentrations for other springs in river water upstream of EMF facilities were also higher than the representative level for groundwater (0.0165 mg/l, Bannock Range; and 0.040 mg/l, Portneuf River Valley), but they most likely represent naturally occurring levels, similar to higher lithium concentrations.

Lithium in River. Lithium was detected in samples from all river sampling stations except gaining-reach stations SW12E (dissolved lithium) and SW7E (total lithium). Mean lithium concentrations for all river sampling stations were comparable to or higher than the representative levels for groundwater. Upstream from the EMF facilities, lithium was present at higher levels in river water than in representative groundwater, and its presence does not represent an impact from the EMF facilities.

As shown in Table 4.5-3, mean lithium concentrations in samples from river sampling stations decreased from a high value of 0.058 mg/l total lithium at SW25 and SW24 to a mean concentration of 0.037 mg/l (total and dissolved) for lithium in the gaining-reach sampling stations. Figure 4.5-3 illustrates this trend in lithium concentrations.

Vanadium in Springs. Vanadium concentrations were near detection limits in most samples from spring and spring-drainage sampling points in the EMF study area. These concentrations were below the representative levels for groundwater (0.10 mg/l, Bannock Range; and 0.199 mg/l, Portneuf River Valley).

The mean vanadium concentrations presented in Table 4.5-2 are not a clear representation of vanadium detected over four rounds of surface water sampling, as concentrations varied by two orders of magnitude. During the initial round of surface water sampling in July 1992, reported vanadium concentrations for spring-related sampling points (0.04 to 0.13 mg/l) were much

higher than those reported for subsequent rounds of sampling (maximum 0.011 mg/l). During the April 1993 round of sampling, vanadium was not detected in any surface water sample.

Vanadium concentrations are illustrated for a sampling point from each of the four spring systems in Figure 4.5-4. The higher vanadium concentrations detected among the samples collected during the July 1992 sampling event may reflect the influence of field or laboratory procedures which resulted in artificially high vanadium concentrations.

Vanadium in River. Vanadium concentrations were near detection limits in samples from river sampling stations in the EMF study area. There was a small increase in the mean vanadium concentrations from upstream to downstream; however, the vanadium concentrations in gaining reach river water were below the representative levels for groundwater (0.100 mg/l, Bannock Range; and 0.199 mg/l, Portneuf River Valley).

The mean vanadium concentrations presented in Table 4.5-3 are not a clear representation of vanadium detected over four rounds of surface water sampling, as concentrations varied by an order of magnitude. During the July 1992 sampling event, the reported vanadium concentrations for six river sampling stations were much higher (0.04 to 0.08 mg/l) than for subsequent rounds of sampling (maximum 0.003 mg/l). Vanadium was reported as "not detected" for the remaining nine river sampling stations during the July 1992 sampling event with detection limits ranging from 0.015 to 0.190 mg/l. During the April 1993 round of sampling, vanadium was not detected in any surface water samples, and sample detection limits were 0.004 mg/l.

The vanadium concentrations for river sampling stations are illustrated in Figure 4.5-5. Based on four rounds of sampling, it is possible that these concentrations are associated with a seasonal fluctuation in concentrations. However, the "trend" is more likely an effect of field or laboratory procedures which resulted in artificially high vanadium concentrations for July 1992.

Aluminum in River. Total aluminum was detected routinely in samples from the majority of river sampling stations in the losing reach of the Portneuf River: SW25, SW24, SW23, SW20, SW19, and SW16. Aluminum concentrations in samples from SW16 and SW25

are illustrated in Figure 4.5-6. At other sampling locations, total aluminum (Table 4.5-3) was detected in only one or two samples. Dissolved aluminum (Table 4.5-3) was detected in only one or two samples collected from each location.

The presence of aluminum in surface water samples as total aluminum rather than dissolved aluminum is generally an indicator of a turbid water sample due to the presence of suspended solids. Total aluminum was detected in all river samples for April 1993 when riverflow was at a maximum for all sampling events.

Iron in River. Total iron was detected in river water samples as a result of suspended solids. Seasonally high levels of total iron resulted from increased turbidity that occurred during periods of increased flow in the Portneuf River. Total iron was routinely detected at all river sampling stations except SW25 and was present at higher concentrations in the losing reach than in the gaining reach of the Portneuf River.

Mean dissolved iron concentrations (Table 4.5-3) for all the river sampling stations and mean total iron for SW25 reflect only one or two samples in which iron was reported. Dissolved iron was near detection limits in all river water samples from the EMF study area.

The mean total iron concentrations are not a clear representation of iron detected over four rounds of surface water sampling as concentrations varied by two orders of magnitude. Total iron concentrations ranged from below detection to 0.32 mg/l for all river samples for the first three rounds of sampling (Appendix U). However, total iron concentrations ranged from 0.94 to 1.73 mg/l in river water samples during the April 1993 sampling event. Figure 4.5-7 illustrates this trend in total iron concentrations for SW22 and SW16 in the losing reach, and SW10 and SW08 in the gaining reach.

Comparison of group means provided in Table 4.5-3 for losing-reach versus gaining-reach river stations shows that during both the low flow (first three events) and high flow (April 1993) sampling events, iron concentration were greater in the losing-reach than the gaining-reach.

Manganese in River. Total manganese was routinely detected at all river sampling stations except SW21, and was present at higher concentrations in the losing reach than in the gaining reach of the Portneuf River. For the July 1992 round of sampling, manganese was reported in only two samples (0.037 mg/l for SW20 and 0.012 mg/l for SW01).

Total manganese was detected in river water samples due to the presence of suspended solids; manganese was not present in filtered river water samples. Seasonally high levels of total manganese resulted from increased turbidity which occurred during periods of increased flow in the Portneuf River.

Similar to aluminum and iron, the presence of manganese in surface water samples as total manganese rather than dissolved manganese was generally an indicator of a turbid water sample. The conclusion drawn from this observation is further supported by comparing total manganese concentrations with river flow. Total manganese was detected in all river samples for April 1993, when river flow was at a maximum for all sampling events.

The mean total manganese concentrations presented in Table 4.5-3 are not a clear representation of manganese detected over four rounds of surface water sampling, as concentrations increased twofold to fourfold for the April 1993 sampling event. Total manganese concentrations ranged from below detection to 0.014 mg/l. However, total manganese concentrations ranged from 0.037 to 0.062 mg/l during the April 1993 sampling event. The total manganese concentrations for sampling stations SW25, SW16, SW12, and SW03 are illustrated in Figure 4.5-8.

Comparison of group means provided in Table 4.5-3 for losing-reach versus gaining-reach river sampling stations shows that total manganese concentrations were approximately the same for the losing-reach and gaining-reach river sampling stations.

Nutrients, Fluoride, and Sulfate

Ammonia in River and Springs. Mean ammonia concentrations were at representative groundwater levels (0.5 mg/l) or below detection levels in samples collected upstream from the

EMF site. Ammonia was detected in Batiste Spring as part of the groundwater monitoring program. Downstream from the EMF site, in the gaining reach of the river, mean ammonia concentrations were highest at SW12 (3.4 mg/l) and decreased further downstream. Elevated concentrations of ammonia at SW12 were attributed to the STP discharge. These observations agree with the STP bioassessment of the Portneuf River (City of Pocatello, 1989). The ammonia introduced into the surface water via Batiste Spring was intermittent, and samples collected along the spring drainage channel at SW11 did not contain detectable levels of ammonia, indicating the total ammonia contribution at Batiste Spring was not high enough to be measurable at points downstream.

Nitrate in Springs. Nitrate was detected at spring sampling stations at mean concentrations ranging from 1.40 to 4.44 mg/l (Table 4.5-4 and Figure 4.5-9). The highest mean nitrate concentrations were found at Batiste Spring (4.44 mg/l), Swanson Road Spring (2.64 mg/l), STP Spring (3.41 mg/l), and Papoose Spring (2.98 mg/l) (Table 4.5-4). Mean nitrate concentrations were lower at sampling points in the drainage channels of Batiste Spring and Papoose Spring (Table 4.5-4).

Note that the STP spring (SW13) has Portneuf River Valley hydrogeochemical characteristics and is located along the east bank of the river. EMF-related groundwater does not impact this spring.

Individual nitrate results for each spring-related sampling point for each sampling round during the RI are shown in Figure 4.5-10. Nitrate concentrations for the springs in the East Side System were generally above 3 mg/l. Slightly elevated nitrate concentrations were detected at the spring within the STP operations area (SW13).

The nitrate concentration of 11 mg/l at Batiste Spring in the April 1993 sample may represent a unique or intermittent event that impacted groundwater and, subsequently, Batiste Spring (Figure 4.5-10). During April 1993, total phosphorus and sulfate at Batiste Spring were also elevated above levels found in previous rounds of sampling (Appendix U).

Nitrate in River. Nitrate concentrations were consistently higher in the gaining reach than in the losing reach of the river (Table 4.5-5). Representative groundwater is a potential source of nitrate in the gaining reach (Figure 4.5-11), due to the relatively high levels of nitrate found in background Michaud Flats and Portneuf River Valley groundwater. The representative nitrate concentrations were 5.52 mg/l and 4.0 mg/l in these two hydrogeochemical regimes.

To the east of the Portneuf River, nitrate in groundwater (3.0 to 3.4 mg/l in Wells 512 and 513) may be related to agricultural activities on the Portneuf River floodplain or to private septic systems. To the west of the river, similar nitrate levels might also be associated with agricultural activities throughout the Michaud Flats, private septic systems, and the land application of sewage sludge in an area north of I-86.

River station SW17 had consistently higher concentrations of nitrate than other losing-reach stations (up to 1.62 mg/l in October 1992). Nitrate levels in the river at SW17 were attributed to the FMC IWW ditch outfall. The maximum nitrate concentration found in a Phase II sample at SW17 was 0.72 mg/l, and the mean concentration in the Phase II samples was 0.57 mg/l. Therefore, it appears that the nitrate concentration detected at SW17 during Phase I resulted from the IWW discharge of nitrate-containing background groundwater (Tables 4.5-1 and 4.5-1a).

As shown in Figure 4.5-11, the highest nitrate levels detected for three out of the four sampling events were detected in samples collected at the downstream stations SW07E to SW01. SW01 was the furthest downstream river sampling station in the RI sampling program. During July 1992, nitrate concentrations for SW01 (2.8 mg/l) and the next station upstream, SW03 (2.7 mg/l), were high compared with other gaining-reach stations.

Water quality sampling conducted by Perry (1977) found that the annual mean concentration of nitrate-N was the greatest at Siphon Road Bridge. This location is the same as RI sampling station SW03 and was the furthest downstream location sampled during Perry's 1975 investigation.

Elevated nitrate concentrations were also detected at stations 5E and 5F (Table 4.5-4), with mean concentrations of 2.47 and 2.56 mg/l, respectively. These stations are located below the Papoose Springs Fish Farm.

In summary, non-EMF activities have increased nitrate concentrations in groundwater that discharges to the Portneuf River, thereby increasing the overall nitrate concentrations in the river. Additionally, nitrates may form as the ammonia discharged from the STP is oxidized, further increasing the nitrate concentrations downstream from the STP. Nitrates are also discharged to the river via groundwater from the EMF site; however, these nitrate loadings are not sufficient to increase the nitrate concentrations along the entire gaining reach of the river (Section 5.4).

Orthophosphate and Total Phosphorus in Springs. Mean orthophosphate and total phosphorus concentrations were at or near the detection limit (0.03 mg/l) at springs SW13, SW09, SW07, SW06, SW04, and SW02 (Figures 4.5-12 through 4.5-15). Orthophosphate concentrations in representative groundwater ranged from 0.06 mg/l to 0.27 mg/l in the three hydrogeochemical regimes. Total phosphorus ranged from 0.15 mg/l to 0.33 mg/l in the three regimes (Table 4.5-4).

Orthophosphate and total phosphorus concentrations were highest at Batiste Spring (SW14), with mean orthophosphate at 2.36 mg/l and mean total phosphorus at 2.71 mg/l. Concentrations decreased downstream along the Batiste Spring drainage channel as evidenced by the mean concentrations of 0.59 and 0.48 mg/l at SW11. Mean orthophosphate and total phosphorus concentrations at Swanson Road Spring (SW15) were 0.99 and 1.05 mg/l, respectively. These levels also exceeded representative groundwater levels.

Orthophosphate and Total Phosphorus in River. Total phosphorus and orthophosphate concentrations were higher in samples collected from the gaining river reach compared with the losing reach (Table 4.5-5 and Figures 4.5-12 through 4.5-15). Although concentrations were generally very low, total phosphorus was present in groundwater beneath the EMF operations areas. Shallow monitoring well 503 near the west bank of the Portneuf River had elevated levels

of total phosphorus that can be attributed to the EMF facilities. Elevated mean total phosphorus concentrations in Swanson Road and Batiste Springs are attributed to the EMF facilities.

Relatively high mean total phosphorus concentrations (0.22 mg/l) were found at the point where Papoose Spring discharges to the Portneuf River (SW05). This sampling point is downstream of the Papoose Springs Fish Farm. As total phosphorus was not elevated in the spring (SW07) and spring drainage (SW06) above the fish farm, the total phosphorus at SW05 is attributed to the fish farm.

Individual total phosphorus results are shown in Figures 4.5-13 and 4.5-15. These figures show that total phosphorus concentrations in the gaining reach of the Portneuf River were consistently highest at SW12. This river sampling station is located at the STP discharge and is upstream from where the Batiste System discharges into the river.

Water quality sampling conducted by Perry (1977) found that Pocatello STP effluent had much higher concentrations of total phosphorus (8.2 mg/l) compared to other effluent sources to the Portneuf River.

Losing-reach sampling station SW17 had mean total phosphorus concentrations (0.64 mg/l) above those detected in samples collected at the gaining-reach river sampling stations (Table 4.5-5). The total phosphorus concentration measured at station SW17 (0.64 mg/l) was likely attributable to discharge of background groundwater and IWW ditch water that may be slightly elevated in total phosphorus. Phase II sampling conducted at SW17 showed mean total phosphorus concentrations of 0.14 mg/l, lower than the Phase I findings (Tables 4.5-1 and 4.5-1a).

Fluoride in Springs. Mean fluoride concentrations for all 12 spring sampling points ranged from 0.3 to 0.8 mg/l (Table 4.5-4). Representative groundwater fluoride concentrations were 0.6 mg/l for Bannock Range groundwater, 0.8 mg/l for Michaud Flats groundwater, and 0.41 mg/l for Portneuf River Valley groundwater. Historical analysis of fluoride in springs

(Perry, et. al., 1990) indicated that the Papoose springs generally had higher fluoride than springs closer to the EMF facilities.

In characterizing the spring groups, Perry et al. (1990) found fluoride concentrations to be significant. Historically (from 1978 to 1980), fluoride concentrations were four to five times greater (1.32 mg/l) in the Papoose System compared with fluoride concentrations in the other three spring groups (0.30 to 0.44 mg/l). During the RI, the highest mean fluoride concentrations (0.7 and 0.8 mg/l) were still found in Papoose System springs. The two East Side System springs (SW13 and SW9) had fluoride concentrations in the 0.30 to 0.44 mg/l range. Mean fluoride concentrations for Batiste Spring (0.6 mg/l) and Swanson Road Spring (0.5 mg/l) were greater than the historical means for these East Side springs and were comparable to fluoride concentrations (0.5 and 0.6 mg/l) in the Papoose Springs (stations SW07, SW06, and SW05). The Papoose Spring System is not impacted by the EMF facilities

Fluoride in River. Both losing- and gaining-reach river sampling stations had fluoride concentrations below 0.5 mg/l. The Phase I sample from SW17 contained 0.7 mg/l of fluoride, similar to the fluoride levels in background groundwater that is discharged via the IWW ditch. Based on Phase I findings, the elevated fluoride level in the river at SW17 may be attributable to the IWW ditch outfall. Subsequent sampling conducted at SW17 showed a decrease in fluoride at this station with a Phase II mean concentration of 0.3 mg/l (Tables 4.5-1a and 4.5-5).

Sulfate in Springs. As indicated in Section 4.4, above-representative level mean concentrations of sulfate in Swanson Road Spring (104 mg/l) and in Batiste Spring (113 mg/l) were attributed to EMF sources (Figure 4.5-16). Sulfate concentrations were also consistently higher in gaining-reach river water (ranging from 54 to 70 mg/l) than in losing-reach river water (38 to 45 mg/l), indicating that the groundwater recharging the river contains higher sulfate concentrations than the upstream river water. However, the overall increase in sulfate concentrations downstream of the EMF facilities was not solely attributable to the EMF-derived sulfate discharges at the springs.

Sulfate in River. Figure 4.5-17 shows that sulfate concentrations in the gaining reach of the Portneuf River were generally highest at SW12 (mean concentration of 65.4 mg/l). This river sampling station is located at the STP discharge and is upstream of the Batiste Spring discharge point. The STP contributes to the higher levels of sulfate in the gaining reach of the Portneuf River.

As seen in Figure 4.5-17, river sampling station SW17 had generally higher sulfate concentrations than other losing-reach river sampling stations. The Phase I sulfate results at SW17 are indicative of the sulfate in groundwater discharged via the IWW ditch to the river. Phase II sampling indicated a mean sulfate concentration of 35 mg/l at SW17. The Phase II sulfate levels were comparable to other losing-reach river sampling stations, which ranged from 38 to 45 mg/l in Phase I.

Radiological Parameters in River and Springs

Surface water analytical results for gross alpha, gross beta, radium-226, radium-228, and uranium-233/234 are discussed in this section. Samples were also tested for uranium-235 and uranium-238, and neither isotope was detected.

To assess the nature and extent of radiological parameters in springs that could be attributed to the EMF facilities operations, sampling results from spring sampling stations were compared with each other. Since EMF-affected groundwater enters the surface water system at Swanson Road and Batiste springs, results for these two springs were compared to the other springs in the study area (Table 4.5-6).

With respect to the Portneuf River, radiological parameters in surface water samples collected from the gaining reach were compared with those collected from the losing reach. Particular consideration was given to sampling stations between SW16 and SW20 (in the vicinity of the EMF facilities), including SW17, located at the FMC outfall (Table 4.5-7). A tabulation of all radiological analyses for each surface water sample collected during the RI is presented in Appendix U.

Gross alpha, radium-226, and radium-228 activities in springs and spring drainages revealed no discernible trends that would indicate potential anthropogenic impacts. The maximum gross alpha activity among all of the springs was detected at SW07 (Papoose Spring) at an activity of 8.84 ± 2.30 pCi/l. Gross alpha activity in Batiste and Swanson Road Springs was comparable to gross alpha activity in other springs.

Radium-226 was detected in three samples from SW07, with activity ranging from 1.40 ± 0.38 pCi/l to 1.93 ± 0.52 pCi/l. A radium-226 activity of 5.20 ± 0.26 pCi/l was detected in SW05 during the October 1992 sampling event. Radium-226 was also detected at SW11 at an activity of 2.60 ± 0.40 pCi/l and at SW15 with activity measurements of 1.50 ± 0.62 pCi/l and 1.82 ± 0.25 pCi/l.

Radium-228 was not detected at SW14, SW11, and SW09. In other spring sampling locations, radium-228 was detected in at least one round. At SW15, radium-228 activity was comparable to the activity detected at other spring sample stations. The highest activities of radium-228 were measured at SW04 (3.5 ± 0.9 pCi/l) and SW02 (5.3 ± 1.2 pCi/l).

Gross beta radiation was detected at every spring during every round of sampling. No single sampling event consistently exhibited the highest gross beta activities. Most if not all gross beta radiation in spring samples are believed to be attributable to potassium-40 (K^{40}), a beta emitter. Using the detected concentration of potassium, the activity of K^{40} was estimated for each sample. The natural radioactive decay calculated from K^{40} -derived beta emissions as a percentage of the gross beta emissions measured in the spring samples is presented in Table 4.5-8.

Samples from selected springs (SW14, SW13, and SW05) were analyzed for uranium isotopes during the February 1993 round of sampling only. Uranium-233/234 was detected in all three samples at similar levels (1.08 ± 0.27 , 1.67 ± 0.52 , 1.19 ± 0.32 pCi/l, respectively). SW14 (Batiste Spring) is known to be impacted by EMF-related constituents and the other two springs

are not impacted. The levels of uranium-233/234 detected in all three springs are considered representative of unimpacted groundwaters. Uranium-235 and uranium-238 were not detected.

Gross alpha radiation was detected at all river sampling station sampling points sampled during the February 1993 round of sampling (Table 4.5-7). Gross alpha radiation was also detected in two or three rounds of sampling at SW25, SW23, SW22, SW20, SW19, SW16, and at all downstream river sampling stations.

Gross beta activities showed moderate variations from station to station, with no discernible trend indicating anthropogenic impacts. Gross beta radiation at river sampling stations was detected at every sampling point during every round of sampling, with the exception of SW21 during April 1993. Over three sampling events, upstream river stations had higher activity than downstream stations. The two highest measurements of gross beta activity (12.00 ± 2.00 and 13.80 ± 4.31 pCi/l) were at SW01 and SW23, respectively. However, these two stations also had the lowest activities of gross beta in other rounds of sampling. In general, gross beta levels appeared to decrease from the furthest upstream river location (SW25) to the furthest downstream locations (SW03 and SW01).

As in spring samples, a large percentage of gross beta radiation in river water samples is attributable to the natural abundance of K^{40} . Table 4.5-8 presents the natural radioactive decay calculated from K^{40} -derived beta activity as a percentage of the gross beta measured in the surface water samples. It is apparent that most, if not all, beta radiation can be attributed to the naturally occurring radioisotope K^{40} in the Portneuf River water.

Radium-226 was detected in one sampling round at stations SW25, SW24, SW19, SW12E, and SW01 and in two sampling rounds at stations SW17 and SW03. Radium-228 was detected at least once in all upstream river stations except SW22 and was detected in three rounds of sampling at SW23, SW21, and SW20. Radium-228 was detected during one round of sampling at the downstream stations SW12E, SW12, SW07, and SW01. Results for both radium-226 and

radium-228 indicate only moderate variations, with no clear distinctions between losing-reach and gaining-reach stations.

Samples from stations SW25, SW24, SW22, SW17, SW10, and SW1 were analyzed for uranium isotopes during the February 1993 round of sampling only. Uranium-233/234 was detected at comparable activities (1.12 ± 0.47 to 1.40 ± 0.35 pCi/l) in all six samples. Uranium-235 and uranium-238 were not detected.

4.5.2 NATURE AND EXTENT OF EMF-RELATED CONSTITUENTS IN SEDIMENTS

The nature and extent of EMF-related constituents in sediments were investigated using statistical comparisons of constituent concentrations in different sample groups, cluster analysis, and direct comparison of sediment chemical concentrations to representative soil concentrations. The results of these comparisons and analyses were used to draw conclusions as to the nature and extent of EMF effects on river and spring sediments. The highest degree of confidence was placed on the statistical analyses. The comparison of sediment concentrations with soil concentrations is a more qualitative comparison because sediment chemistry is not directly comparable to surface soil chemistry.

In two locations, SD11 and SD9, silt and clay-rich sediments were collected in a spring pools with very low current velocities. These two locations are within the area of surface soils that have been influenced by EMF emissions. The EMF effects resulting from surface runoff pathways and aerial deposition pathway, if significant, would likely have been reflected in these sediment samples.

4.5.2.1 Sediment Chemistry Data – Overall Results

The only sediment sample that directly reflected a release from the EMF facilities was SD17, collected at the IWW ditch outfall. The investigation in the area of the outfall demonstrated a very localized effect. Statistically significant elevated chemical concentrations were not encountered at sample locations further downstream.

Cadmium, chromium, vanadium, zinc, fluoride, and total phosphorus were detected in sediment sample SD17 at concentrations in excess of the upstream sediment concentrations and representative soil concentrations (Tables 4.5-9 and 4.5-10; Figures 4.5-18 and 4.5-19).

Sediment samples collected downstream from SD17 in the river channel and spring drainages did not contain elevated concentrations of cadmium, chromium, vanadium, zinc, or fluoride, and one downstream sample, SD10, had higher total phosphorus than SD17 (Tables 4.5-11 and 4.5-12; Figures 4.5-20 and 4.5-21).

Sample SD10 contained 7,150 mg/kg total phosphorus, the highest of any sediment sample. This sample was collected from the river channel where it is joined by the Batiste Spring drainage. The next highest concentration of total phosphorus was found at the IWW ditch outfall (5,340 mg/kg). Concentrations above the upstream sediment and representative soil levels were observed in the Fort Hall Bottoms (SDC1 at 1,160 mg/kg and SDC4 at 1,060 mg/kg).

Arsenic values exceeded upstream sediment and soil representative levels at stations SD18 (8.4 mg/kg) and SD8 (9.9 mg/kg). Spring sediment samples that exceeded the upstream sediment and representative soil level for arsenic were samples SD4 at Siphon Road Spring (8.2 mg/kg), SD7 at Papoose Spring (9.1 mg/kg) and SD2 at Twenty Spring-East (13.8 mg/kg). The Papoose Spring sample was taken in a ponded water area with very low energy, and the sample from Twenty Springs was taken in a low-energy swampy area. Like the river sediments, neither of these stations contained the suite of metals, fluoride, and total phosphorus associated with the EMF facilities. Therefore, the constituents found in these sediments are not reflective of EMF effects.

The highest levels of lead were detected in upstream sampling locations SD23 and SD24 (71.9 mg/kg and 51.6 mg/kg) respectively (Figure 4.5-22). Given the upstream locations of these samples relative to the EMF facilities, it is clear the lead is not related to the EMF facilities. The next highest lead concentrations in river sediment were found at locations SD19 and SD20. In general, lead concentrations were higher in upstream samples than in downstream samples.

Figure 4.5-23 displays the lead values detected in the spring sediments. The discharge point of the Papoose System contained the highest level of lead detected in spring sediment (50.5 mg/kg).

Mercury was detected in one upstream location, SDA1, at a concentration of 0.55 mg/kg and one downstream location, SDB1, at a concentration of 1.1 mg/kg (Figure 4.5-22). The occurrence of mercury in the river sediments does not appear to be related to any identified specific source along the river and may, in fact, be naturally occurring (Appendix Q.)

Gross alpha activities appear to be related to soil textures, with sediments rich in clay or gravel being generally higher than those containing silt or sand. Sample location or proximity to the EMF site does not appear to be a factor. The one exception was at the IWW ditch outfall, which had the highest level of gross alpha activity (29.2 ± 3.6 pCi/g).

Gross beta activities were positively correlated with potassium-40 content, with some exceptions. Gross beta activities were less than representative soil levels.

4.5.2.2 Sediment Statistical Comparisons

Sediment samples were compared statistically using several different methods: t-tests, non-parametric ANOVA (analysis of variance), and cluster analysis. The student's t-test uses the reported concentrations of chemicals and allows for a one variable (chemical) comparison between two groups of samples. It assumes a normal distribution. The objective in performing a student's t-test was to investigate differences between results for statistical significance. The non-parametric ANOVA is a test that is independent of the population distribution and the presence of nondetects in the dataset. The non-parametric ANOVA highlights differences that may be present, although masked by nondetects or other "noise" in the dataset. The cluster analysis compares sediment samples using numerous analytes concurrently, whereas the t-tests and ANOVA can only be applied to one analyte at a time.

Student's t-test. Sediment samples were assigned to spring, upstream, near-site, and downstream groups for statistical comparisons (Table 4.5-13). The spring and near-site samples

were placed into separate groups to ensure that any influences from the EMF site would be identified in the statistical tests. Samples in the spring group are SD2, SD4, SD5, SD6, SD7, SD9, SD11, SD13, SD14, and SD15. Samples in the near-site group most likely to reflect the cumulative effects of IWW ditch outfall, surface runoff, and direct aerial deposition to the river are SD16, SD18, SD19, and SD20. Samples SD21, SD22, SD23, SD24, SD25, SDA1, and SDA2 form the upstream group, which is least likely to be affected by EMF-related activities. The downstream sediment sample group includes SD12, SD10, SD8, SD3, SD1, SDB1, SDC1, SDC2, and SDC4. Sample SD17 was not included in any group because it reflected EMF-related influences.

The test hypothesis was that the sediment sample groups were collected from the same sediment population. The hypothesis was tested at the 95% confidence level. Where the absolute value of the calculated t-value was greater than the corresponding 95% confidence interval t-value from the statistical table, the hypothesis would be rejected. Rejection of the hypothesis would indicate that the two sample groups were not collected from the same population, and that there is a statistically significant difference between their mean concentrations.

Results of the t-tests show that sample means for near-site sediments are not statistically different from upstream sediment means for any constituents, except iron (Table 4.5-13). Iron is the only constituent for which there was a statistically significant difference between the sample means of the two sediment groups, with upstream sediments having a higher iron content.

When spring sediments were compared with the upstream sediments, the upstream sediments had higher mean concentrations of aluminum, copper, lithium, manganese, and nickel. Spring sediments were higher in beryllium, which is likely a result of the elevated beryllium concentrations in samples SD9 (FMC Employee Park) and SD2 (Twenty Springs East).

Upstream sediments had statistically higher concentrations of cobalt, manganese and vanadium at the 95% confidence level, compared with spring sediments. This result is particularly

important for vanadium given that it is a characteristic constituent of EMF potential source materials (e.g., ore and precipitator dust).

There was no statistically significant difference in total phosphorus content between upstream and downstream sediment even though the mean total phosphorus concentration in the downstream sediment sample group was 1,463 mg/kg compared with a mean in the upstream sediments of 357 mg/kg. This indicates that, although there was a higher concentration of total phosphorus at SD10, the overall total phosphorus content of downstream sediments is not statistically different from the upstream sediments.

Non-Parametric ANOVA. A non-parametric test, instead of a t-test, was used to evaluate selenium, mercury, thallium, and cadmium because these datasets contained a high proportion of nondetects. The nonparametric ANOVA or Kruskal-Wallis tests whether any of the sediment sample groups are from a different population. This is tested at the 95% confidence level. The same sediment groups used in the t-test analyses were used in the ANOVA analysis. The test results indicate no differences between sediment sample groups for mercury, selenium, thallium, or cadmium (Table 4.5-13).

Molybdenum was detected in only one upstream sample, and antimony was not detected in any sediment sample. Therefore, neither of these parameters were tested for significance using either the t-test or non-parametric ANOVA.

Cluster Analysis. A cluster analysis was performed on the sediment data for manganese, aluminum, iron, total phosphorus, fluoride, zinc, barium, arsenic, gross beta, lead, cadmium, chromium, copper, vanadium, and selenium. These analytes were selected because these analytes best encompassed the overall dissimilarities in the sediment composition. Note that the six characteristic constituents are included in this grouping. Other metal and radiological constituents (e.g., Ni, Li) correlated well with one or more of the constituents used in the cluster analysis, and would only have served to reduce the “dissimilarity” between samples had they been included.

The results indicate that SD17 (Phase I IWW outfall) and SD17A (Phase II IWW outfall) are very dissimilar to other samples, and are not very similar to one another. SDB1A, collected from a public boat launch area, is also very distinct from other samples. According to the cluster analysis, it is most similar to SDA1, which was collected several thousand feet upstream from the EMF site. If SDA1 does not reflect any EMF-related impacts (which is likely since there is no pathway between the site and SDA1), then it follows that the chemistry of sample SDB1A does not necessarily reflect EMF-related influences. Why these two samples are different from the others cannot be explained with the available data.

Sample SD10, which contained the highest total phosphorus concentration, is most similar to SD13, the sediment sample collected at the STP spring pond. If SD10 were indicative of EMF-related impacts to the river, SD10 might have been expected to be more similar to SD14, SD17, SD17A, or SD15, because these samples were collected in the immediate vicinity of EMF-related discharges.

Upstream sediments are not similar to each other and show the same degree of similarity to downstream and spring sediments. Because upstream sediments, downstream sediments, and spring sediments do not show distinct groups that are spatially related to EMF discharges or transport pathways, the cluster analysis demonstrated that there is no distinct EMF fingerprint in the sediments.

4.5.2.3 River Sediments – Detailed Discussion

A detailed discussion of the chemical characteristics of river sediments upstream of all EMF-related discharges to the Portneuf River is presented below. This characterization of upstream sediments provides a basis for evaluating the analytical results for sediment samples collected in areas that might have been influenced by pathways that transport EMF-derived constituents to surface water sediments. This characterization of upstream sediments is followed by a sample-by-sample discussion of sediment samples collected in the Portneuf River channel. Conclusions regarding EMF-related influences are based on the results of the statistical tests

(Section 4.5.2.2), comparisons with upstream sediment concentrations and soil representative levels, the presence of characteristic EMF parameters, and the presence of a pathway between the EMF facilities and the river sediment and depositional environment. A sample-by-sample discussion of the spring sediment samples is presented in Section 4.5.2.4.

Upstream Sediments (SD25 to SD21, SDA1 and SDA2). Upstream sediment samples exceeded the soil representative levels for aluminum (SDA1), boron (SDA1), copper (SDA1 and SD23), lead (SD24 and SD23), manganese (SD25), mercury (SDA1), molybdenum (SD21), and zinc (SDA1) (Table 4.5-9). The upstream sediments did not contain orthophosphate or total phosphorus at concentrations in excess of the representative levels. Fluoride exceeded its representative level of 600 mg/kg in SD23 (1,300 mg/kg). Despite these differences, it appears that the upstream sediments were generally similar in chemical composition to local soils. Slightly higher zinc, copper, mercury, and lead concentrations may be due to discharges to the river from potential sources within Pocatello or further upstream. Alternatively, the higher concentrations may be indicative of natural variability within the river system. Regardless, the upstream sediment metal concentrations were similar to soil representative levels.

Sample SD20. Location SD20 is approximately 1,800 feet downstream from SD21 (Figure 4.5-1f). The texture of sample SD20 was a sand with silt and gravel. Lead (61.0 mg/kg) and silver (3.0 mg/kg) exceeded representative levels. All other constituents were within soil representative levels, including the EMF characteristic metals. This location was not impacted by EMF operations.

A comparison of the results found at this location with the upstream samples indicates similar, but generally lower concentrations of metals and nutrients (Tables 4.5-9 and 4.5-10). This result is expected since the sample was a sand rather than a clay, and less likely to contain naturally occurring trace metals in its matrix or to contain adsorbed metals.

Sample SD19. Location SD19 is approximately 1,000 feet downstream from SD20 (Figure 4.5-1f). The texture of this sample was a silty clay. Lead (38.6 mg/kg) and copper

(12.7 mg/kg) concentrations exceeded soil representative levels. Higher lead, copper, and fluoride concentrations were detected in other samples further upstream, so their occurrence here does not indicate an EMF-related impact. This sample does not appear to be indicative of EMF facility impact.

Sample SD18. Location SD18 is near the old FMC and Simplot outfalls. It is approximately 350 feet downstream from SD19. The texture of the sediment was sand with gravel. Arsenic was detected at 8.4 mg/kg, above the representative soil level of 7.7 mg/kg. Thallium was detected at a concentration of 0.30 mg/kg compared with a representative level of 0.27 mg/kg. The remaining constituents were below both representative and upstream trace metal levels (Table 4.5-9). The arsenic concentration is likely within the variability of representative levels in the river sediments. Because the reported thallium value was an estimated value (i.e., J qualifier) that is very close to the representative level for soils, thallium was not considered elevated.

Sample SD17. Sample location SD17 is located several feet beyond and downstream of the current FMC outfall. Its texture was a sandy clay. When dried, the material contained a gray, clay-like material with shell and rock fragments. The sand fraction was coarse, pink and purple sand. Also, the sample contained considerable organic matter in addition to the mineral matrix. This sample contained a number of constituents above representative soil levels, including the suite of constituents characteristic of potential sources at FMC (Tables 4.5-9 and 4.5-10). Therefore, the sample is considered to have been influenced by FMC industrial activities. A petrographic thin section of the sample was made and compared with thin sections of slag, phosphate ore, and precipitator slurry. The visual microscopic comparison indicated that the sediment sample contained components of precipitator dust and ore. The presence of ore is not surprising since the IWW ditch runs just to the east of the FMC ore pile. The thin section evaluation report is presented in Appendix I.

During Phase II sampling in July 1993, three additional samples were gathered in the vicinity of the FMC outfall (Figure 4.5-1h). Sample SD17A was collected from the river channel directly in

front of the FMC outfall pipe. FMC had placed a steel plate in front of the pipe to act as a baffle, and the sample was taken behind it. Sampling in front of the pipe was not possible because there was very little space between the plate and the outfall pipe, and the river bottom area had been thoroughly scoured. The texture of the sample taken from this area was a sandy gravel. It contained above-representative levels of various parameters including the suite of FMC characteristic constituents (Table 4.5-14). Sample SD17B was taken downstream on the eastern side of the river (the main channel is along the west side of the river). Its texture was a fine sand with some shell fragments. Sample SD17C was taken on the east border of the river approximately 70 feet (22 m) downstream from the outfall pipe. Its texture was moderate to fine sand with shell fragments. All parameters for samples SD17B and SD17C, with the exception of calcium (102,000 mg/kg and 208,000 mg/kg, respectively), were below representative soil levels, and contained no evidence of the EMF characteristic constituents. The high calcium level were probably due to the dissolution of the shells during sample preparation.

The sampling carried out in the area of the FMC outfall indicates a very localized impact on river sediments around the outfall. Samples collected in the downstream portion of this area and at points further downstream did not contain the EMF characteristic constituents above representative levels and, hence, indicate that there has been no measurable impact beyond the outfall.

Sample SD16. Location SD16 is located north of Batiste Road. The sediment sample was taken on the eastern side of the river. Its texture was silty clay. Copper (30.8 mg/kg), thallium (0.73 mg/kg), and zinc (56.9 mg/kg) were detected in the sample at above representative soil values (Table 4.5-9). The remaining parameters were below representative soil concentrations and upstream sediment concentrations. The absence of high cadmium, chromium, and vanadium, and the low values of fluoride (273 mg/kg) and total phosphorus (554 mg/kg) indicate that the sediments were not impacted by the EMF facilities.

Sample SD12. Location SD12 is located 80 feet (24 m) downstream from the STP discharge. Sediments were collected on the west side of the channel. The sediment texture was

sand. Beryllium (1.1 mg/kg) and silver (2.2 mg/kg) exceeded representative soil concentrations. All other parameters were within both the representative soil range and upstream sediment sample values (Tables 4.5-9 and 4.5-10). It should be noted that, given the geometry of the river at this location, SD12 is probably not an area where deposition from the STP discharge would occur.

Sample SD10. Sample SD10 was collected within the river just downstream from the mouth of Batiste Spring. The texture of the sample taken here was fine sand. Metals, orthophosphate, and fluoride concentrations were below the representative soil concentrations and upstream sediment concentrations (Tables 4.5-9 and 4.5-10). The only constituent above its representative level was total phosphorus, which had a value of 7,150 mg/kg. As illustrated by the statistical test, total phosphorus concentrations in downstream sediments were not significantly higher. The cluster analysis indicated that sediments at SD10 were most similar to those at the STP Spring (SD13).

Sample SD8. Location SD8 is near the mouth of the spring-fed pond at the FMC park (Figure 4.5-1d). The texture of the sample contained considerably more silt and clay than sand. Arsenic was detected in this sample at a concentration of 9.9 mg/kg, compared to a representative soil concentration of 7.7 mg/kg (Table 4.5-9). Although this arsenic concentration may reflect an anthropogenic impact to the Portneuf River, other EMF-related constituents did not exceed representative concentrations.

Sample SD3. Sediment sampled at location SD3 was taken in the river at the bridge at Siphon Road (Figure 4.5-1b). Its texture was loam with sand and gravel. The relatively low aluminum value (3,670 mg/kg) suggests that the portion of the sample tested in the laboratory was more sandy than silt/clay. None of the analytical parameters exceeded representative soil concentrations; all concentrations were below the values found in the upstream samples (Tables 4.5-9 and 4.5-10).

Sample SD1. Sediment sample SD1 had a texture described as loam (e.g., approximately equal portions of sand, silt, and clay). The only parameters that exceeded representative soil concentrations were silver and thallium. Silver was detected at a concentration of 2.1 mg/kg compared with a representative level of 1.9 mg/kg, and thallium was detected a concentration of 0.28 mg/kg compared with a representative level of 0.27 mg/kg. The remaining parameters were within representative levels and generally below those values found in the upstream samples.

Sample SDB1. Location SDB1 sediment was collected at a public boat launching area in the Fort Hall Bottoms and above the high water mark of the American Falls Reservoir (Figure 4.5-1i). Its texture was silty clay. This sample contained numerous parameters above representative soil levels although not generally above values found in the samples upstream of the EMF facilities (Tables 4.5-9 and 4.5-10). Also, not all of the EMF characteristic constituents were present. The lack of elevated levels of vanadium, cadmium, total phosphorus, and fluoride indicates the absence of EMF facilities-related particulates (Tables 4.5-9 and 4.5-10). The presence of trace metals, such as lead (30.9 mg/kg), copper (25.5 mg/kg), mercury (1.1 mg/kg), and zinc (97.1 mg/kg), at above-representative levels may be attributed to high clay content. Other constituents above representative levels were aluminum (16,200 mg/kg), iron (16,100 mg/kg), and total organic carbon (11,074 mg/kg). Aluminum and iron concentrations reflect the high clay content of this sediment. This content, combined with the high organic content, imply a potential for a high metal adsorption/absorption capacity of the soil matrix. Furthermore, the Fort Hall Gravels which outcrop in this area contain native elemental and mineral-phase mercury.

Sample SDC1. Sediment sample SDC1 was taken on the downstream side of a point bar. Its texture was silt with fine sands (Figure 4.5-1i). With the exception of calcium (166,000 mg/kg) and total phosphorus (1,160 mg/kg), all parameters were below representative levels and, in general, below upstream sample levels (Tables 4.5-9 and 4.5-10).

Sample SDC2. River sediment was sampled at location SDC2, approximately 1,000 yards downstream from SDC1 (Figure 4.5-1i). Its texture was silty clay. With the exception of

calcium (88,500 mg/kg), all parameters were below representative soil levels (Tables 4.5-9 and 4.5-10).

Sample SDC4. Sediment sample SDC4 was taken approximately 400 feet downstream from SDC2 (Figure 4.5-1i). Its texture was a clayey silt. Boron and copper were slightly above representative soil levels. Boron was reported at 13.1 mg/kg compared with a representative level of 12.8 mg/kg, and copper was detected at 12.9 mg/kg compared with a representative level of 12.6 mg/kg. Calcium (93,200 mg/kg) and total phosphorus (1,060 mg/kg) were also detected above representative soil levels. Total organic carbon was detected at 9,468 mg/kg.

Radiological Parameters

Gross alpha and gross beta were measured on all sediment samples taken during the investigation. All measurements were below their corresponding soil representative levels.

Gross alpha values ranged from 6.33 ± 2.96 pCi/g (SDA2) to 13.6 ± 1.28 pCi/g (SD23) in the upstream samples (Tables 4.5-15 and 4.5-16). The highest gross alpha activity (29.2 ± 3.6 pCi/g) was found at location SD17, the FMC outfall. This observation is expected since the FMC potential sources (Section 4.2.3) contain alpha emitters. The elevated gross alpha at SD17 corroborates previously discussed evidence of EMF impact at this location.

With the exception of SD17, sediment samples from SD21 to SDC4 all contained 12 pCi/g or less gross alpha, which is less than the high end of the range of the activities detected in upstream samples. Even SDB1, which contained several metals at elevated concentrations, but not those characteristic of EMF potential sources, has a relatively low activity (8.15 ± 3.33 pCi/g). This observation lends additional support to the conclusion that above-representative inorganic parameters found in SDB1 were not related to the EMF facilities.

In summary, the EMF-related discharge responsible for the gross alpha values observed at SD17 does not appear to have impacted sediments further downstream. In addition, the lack of elevated gross alpha activities in river sediments at locations other than SD17 suggest that

impacted offsite surface soils have not migrated to the river as surface runoff. The gross alpha results support conclusions drawn from results for the EMF characteristic constituents.

In examining gross beta values, it should be noted that potassium-40 may be a major contributor to these values. Potassium is generally a major component of natural clay soils and, as has been described previously, it is a major component of several EMF potential sources. However, the gross beta and potassium-40 sediment values (Tables 4.5-15 and 4.5-16) were not always well correlated, indicating another unidentified beta-emitting source. However, all gross beta values, including SD17, were below the representative soil value.

Upstream gross beta activities ranged from 10.2 ± 2.62 pCi/g (SDA1) to 25.3 ± 1.45 pCi/g (SD24). These values reflect the silty/clayey nature of the sediments. The highest activity detected among all the samples was at SD17, where 30 ± 3.15 pCi/g gross beta was detected. This observation is not unexpected since this sediment sample contains EMF-related particulates. Sediment samples collected downstream of SD22, excepting SD17, had gross beta values ranging from nondetect at 5 pCi/g to 16.9 ± 2.35 at SD19. These values support the conclusion that EMF-related impacts are confined to location SD17.

4.5.2.4 Spring Sediments – Detailed Discussion

A sample-by-sample presentation of the spring sediment sampling results is provided in this section. Constituents that exceeded representative soil concentrations are highlighted and discussed. The spring sediments are also compared with the sediments collected from the upstream reach of the Portneuf River. Conclusions regarding EMF-related influences are based on the results of the statistical tests (Section 4.5.2.2), comparisons with representative levels, the presence of characteristic parameters, and the presence of a pathway between the EMF site and the spring.

Sample SD15. Location SD15 is at Swanson Road Spring (Figure 4.5-1e). The sediment texture was a sand with silt. The silver concentration (2.1 mg/kg) exceeded the representative

soil level. Other metals were below representative levels. The total phosphorus concentration was 955 mg/kg, above the representative value of 672 mg/kg. Orthophosphate (4.9 mg/kg) and fluoride (333 mg/kg) were below the representative soil levels.

Samples SD11 and SD14. Sediment samples SD14 and SD11 were collected from Batiste Spring and the spring drainage channel (Figure 4.5-1e). The texture of sample SD14 was sand and gravel. The texture of sample SD11 was clayey sandy gravel sample. Sample SD14 contained above-representative concentrations of copper (13.0 mg/kg), lead (29.5 mg/kg), and barium (324 mg/kg). Sample SD11 contained only one constituent, zinc, at an above-representative value (107 mg/kg). As discussed above, the upstream sediments in the river also had lead and copper concentrations in excess of representative soil levels. This appears to be true of the spring sediments as well. The barium content in Batiste Spring sediments may reflect a localized site-related impact.

The sample from SD11 was not collected in the main Batiste channel, but rather in a low-energy pool that is within the area where aerial deposition of EMF-related materials might be expected to have occurred (offsite soil samples SS45-1C and SS023-1C, Table 4.3-3). As discussed in Section 4.3, surface soil samples (north of the EMF facilities) contained the suite of EMF characteristic constituents. However, sediment sample SD11 did not. Since the characteristic constituents were not evident in the sediment, neither air deposition nor overland runoff appear to have had measurable impacts on sediment, even in an area of quiescent surface water. The quiescence of this surface water body is substantiated by the occurrence of clay in the sediments. Deposition of clays on freshwater substrates requires extremely low current velocities in the overlying water column. If significant quantities of EMF materials were transported via the air pathway to surface water and sediments, the particulates would likely be clay size or smaller (less than 1/256 mm), and extremely low current velocity would be necessary for these particulates to collect in sediments.

Sample SD13. Sample SD13 was collected between the Portneuf River and the Pocatello STP sludge-drying beds (Figure 4.5-1e). The spring, located on STP property, has a fairly large

spring pond with sandy sediment as the substrate. The texture of sample SD13 was sand. The sample (Tables 4.5-11 and 4.5-12) contained above-representative levels of total phosphorus (3,950 mg/kg), fluoride (800 mg/kg), and selenium (3.5 mg/kg). The most probable source for the elevated constituents is the STP sludge drying beds. As described in Section 4.4, the springs along the eastern side of the river do not discharge any groundwater impacted by EMF-related activities, thus eliminating the possibility that selenium, total phosphorus, or fluoride in the sediment sample is from the EMF site.

Sample SD9. Sediment sample SD9 was taken at the spring-fed pond at the FMC park (Figure 4.5-1d). Its texture was a loam. This spring is fed by the Portneuf River Valley hydrogeochemical regime and is uninfluenced by EMF facilities-related groundwater because the spring is located on east side of the river. Beryllium (1.40 mg/kg) was above the representative soil level of 1.0 mg/kg. As was true with SD11, this very quiet pond is also within the influence of potential air deposition from the EMF facilities, as shown by impacted offsite soil sample 000-2A (Table 4.3-3), and as was true at SD11, there was no measurable evidence of an EMF-related impact in the sediment. This observation further supports the conclusion that neither air deposition nor overland runoff is a pathway for sediment impact.

Samples SD5 and SD7. Sampling stations SD7 and SD5 are located in the Papoose Spring System (Figure 4.5-1c). Neither spring is downgradient of sources impacting groundwater within the EMF facilities. Sediment sampled at location SD7 was taken in the northeastern portion of the pond fed by Papoose Spring. Its texture was clayey, sandy gravel. Sediment sample SD5 was taken at the mouth of the spring reach as it entered the Portneuf River. Its texture was silty clay. There was an operating fish farm between the two sampling points at the time of sampling. The only parameter with an above-representative concentration in SD7 was arsenic at 9.1 mg/kg. The arsenic representative level for soils is 7.7 mg/kg. The sample collected at station SD5 contained above-representative soil levels of lead (50.5 mg/kg), thallium (0.30 mg/kg), and zinc (54.3 mg/kg). (Soil representative levels are 29.1 mg/kg for lead, 52.8 mg/kg for zinc, and 0.27 mg/kg for thallium.) As noted before, the lead in sediments throughout

the Portneuf River exceeded representative levels at upstream locations, indicating lead is enriched by non-EMF sources in the river sediments relative to soils.

Sample SD4. Sample SD4 was taken at a spring near Siphon Road (Figure 4.5-1b). Its texture was loam. Sample SD4 contained 8.2 mg/kg arsenic, which is greater than the soil representative level of 7.7 mg/kg. The remaining parameters detected in this sample were below representative soil concentrations. There is no groundwater pathway for arsenic transport from the EMF site to the sediments in this spring, making the EMF site an unlikely source of the arsenic detected in this sample.

Sample SD2. Sample SD2 was taken on the eastern branch of Twenty Spring (Figure 4.5-1a). The sediment was silty clay. The area in which it was taken was very swampy. In addition, the recovery for the sample was poor insofar as it was reported to consist of only 20 percent solids. Samples with low percent solids content are difficult to quantitate on a dry weight basis, and the results from such quantitation are generally biased high. Hence, while elements reported as detected in the sample were probably present, their reported values were likely overestimates of the true concentrations. Four constituents were reported at concentrations above representative soil levels. These constituents were arsenic (13.8 mg/kg), beryllium (2.2 mg/kg), chromium (54 mg/kg), and vanadium (192 mg/kg). Zinc, generally found in much greater abundance than vanadium in EMF-related materials, was below the representative soil level at 37.4 mg/kg. Fluoride was detected at 75.3 mg/kg, and total phosphorus was detected at 64.5 mg/kg. These two constituents are considered primary indicators of EMF-related impacts; however, the concentrations of these two constituents in sample SD2 are very low compared to other sediment samples. While the four parameters that exceeded representative levels can be found in EMF potential source-related matrices, the levels of other parameters that have a stronger association with EMF materials suggest that this sample had not been affected by EMF-related activities.

Radiological Parameters

Spring sediments, in general, had higher levels of gross alpha than the river sediments (Table 4.5-16). However, the gross alpha activities in all spring sediments were less than the representative soil level (24.7 pCi/g). There was no correlation of gross alpha activity with location. The highest value (19.8 ± 2.49 pCi/g) was detected at SD14 (Batiste Spring), which is fed by Bannock Range water that is impacted by EMF activities. However, a similar value (14.8 ± 1.35 pCi/g) was detected at SD13, located on the east side of the river and fed by the Portneuf River Valley hydrogeochemical regime, uninfluenced by the EMF facilities. The sediments found in the springs and spring drainage channels are locally derived and have somewhat higher gross alpha activity than the upstream sediment sources.

The same pattern exists for gross beta as exists for gross alpha. The highest gross beta activities were found in the more clay-rich sediments (SD2, SD5, and SD9 at 19.7 ± 2.1 , 18.2 ± 2.3 , and 19.5 ± 2.1 pCi/g, respectively). The gross beta representative soil level is 31.4 pCi/g.

Surface and Subsurface Characterizations
Tables for Section 4.5

Section 4 Nature and Extent of Constituents of Potential Concern

TABLE 4.5-1
COMPARISON OF WATER QUALITY AT RIVER STATION SW17 WITH WELL AND IWW DITCH WATER

Parameter	Production Well Water (unimpacted) FMC-1 ^(a)	IWW Ditch Water (Phase I) FSWIWW01 ^(a)	Surface Water (Phase I) SW17 ^(a)	Surface Water (Phase II) SW17 ^(a)
	10/90 ^(b)	9/92 ^(b)	Mean 7/92 - 4/9/93 ^(b)	Mean 7/93 ^(b)
Alkalinity, bicarbonate (mg/l)	187	324	188.3	196
Calcium (mg/l)	87.6	141J	62.2	64.7
Chloride (mg/l)	96	1620	54.6	—
Magnesium (mg/l)	27.7	22	22.6J	23.8
Potassium (mg/l)	11.2	7470J	8.4	6.9
Sodium (mg/l)	50.1	1450J	47.7	29.7
Sulfate (mg/l)	142	8400	65.4	35
Specific conductance at 25°C, µmhos/cm	925	NA	738	—
pH	7.5	NA	8.52	—
Temperature, °C	13.5	NA	17.6	—
Total dissolved solids (mg/l)	585	7460	403.3J	340
Ammonia (NH ₃ as N) (mg/l)	NA	288	ND	0.5
Nitrate (NO ₃ as N), (mg/l)	1.9	18.4	1.29J	0.57
Orthophosphate (PO ₄ as P), (mg/l)	0.45	2210	0.32J	0.08
Phosphorus, total (mg/l)	0.5	2590	0.64	0.14
Fluoride (mg/l)	0.4	61.6	0.65	0.3
Aluminum (mg/l)	NA	7.66J	1.02	1.88
Antimony (mg/l)	NA	ND	ND	ND
Arsenic (mg/l)	0.0115	1.759J	0.0063J	0.0029
Barium (mg/l)	0.113	0.27	0.081	0.114
Beryllium (mg/l)	NA	ND	ND	0.001
Boron (mg/l)	NA	4.53	0.38J	0.09
Cadmium (mg/l)	0.003	0.0341J	0.0003J	ND
Chromium (mg/l)	0.006	ND	0.002J	0.001
Cobalt (mg/l)	NA	ND	0.008	0.004
Copper (mg/l)	0.004	0.163	0.015	0.007
Iron (mg/l)	0.041	4.99J	0.413	1.465
Lead (mg/l)	0.001	ND	0.002	0.001
Lithium (mg/l)	NA	1.599	0.049	0.027
Manganese (mg/l)	0.0394	0.187	0.023	0.048
Mercury (mg/l)	NA	ND	ND	ND
Molybdenum (mg/l)	NA	0.19	ND	ND
Nickel (mg/l)	NA	0.17	0.013	0.01
Selenium (mg/l)	0.0025	4.217J	0.0053	ND
Silver (mg/l)	0.004	0.035	0.0029J	ND
Thallium (mg/l)	NA	0.318J	ND	ND
Vanadium (mg/l)	0.0061	0.83	0.027J	0.002
Zinc (mg/l)	0.0106	5.25	0.039J	0.020
Gross alpha (pCi/l)	NA	186.50	5.80	1.0
Gross beta (pCi/l)	NA	103.58	4.89	9.90
Radium-226 (pCi/l)	NA	NA	0.94	0.50
Radium-228 (pCi/l)	NA	NA	0.50	0.50

Notes: (a) Sample ID
(b) Sample date

ND = Not detected/below detection limit
NA = Not analyzed

J = Estimated value

Table 4.5-1A
Analysis Results for Water Samples Collected from IWW Ditch

Table 4.5-1A

Parameter	NEIC Sample		Phase II Samples																Mean of Phase II Samples	Well 125	
	NEIC 04IW		O307IWA		O307IWD		O307IWE		O307IWF		O307IWG		O307IWH		O307IWN		O307IWP			Range of Values (4/92 - 12/93)	
	Value Reported	Detection Limit	Value Reported	Data Qualifier	Value Reported	Data Qualifier	Value Reported	Data Qualifier	Value Reported	Data Qualifier	Value Reported	Data Qualifier	Value Reported	Data Qualifier	Value Reported	Data Qualifier	Value Reported	Data Qualifier		Minimum Value	Maximum Value Reported
Alkalinity, bicarbonate			168		170		170		178		194		188		180		164		176.5	176	199
Alkalinity, carbonate			0		0		0		0		0		0		0		0		0	0	5
Aluminum, dissolved			0.023	U	0.023	U	0.023	U	0.023	U	0.023	U	0.023	U	0.023	U	0.023	U	0.0115		
Aluminum, total			0.023	U			0.023	U	0.023	U	0.023	U	0.023	U	0.023	U	0.023	U	0.0115	0.023	0.054
Ammonia (NH3 as N)			0.5	U			0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.5	U	0.25	0.2	0.5
Antimony, dissolved			0.045	U	0.045	U	0.045	U	0.045	U	0.045	U	0.045	U	0.045	U	0.045	U	0.0225		
Antimony, total	ND	0.06	0.045	U			0.045	U	0.045	U	0.045	U	0.045	U	0.045	U	0.045	U	0.0225	0.039	0.15
Arsenic, dissolved			0.00867		0.00729		0.00979		0.00922		0.01064		0.00638	U	0.00875		0.00847		0.00546	0.0049	0.0066
Arsenic, total	0.017	0.01	0.00686				0.00679		0.00671		0.00739		0.00741		0.00657		0.00633		0.00687	0.00362	0.0096
Barium, dissolved			0.07917		0.08288		0.08637		0.08408		0.08146		0.08375		0.07961		0.08037		0.08221	0.0825	0.0929
Barium, total			0.08255				0.08615		0.08288		0.08397		0.08463		0.08299		0.0855		0.0841	0.076	0.16
Beryllium, dissolved			0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0005		
Beryllium, total	ND	0.005	0.001	U			0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0005	0.001	0.003
Boron, dissolved			0.17381	J	0.18236	J	0.18299	J	0.1909	J	0.17254	J	0.17727	J	0.18435	J	0.17555	J	0.17997		
Boron, total			0.16219	J			0.17882	J	0.19426	J	0.18145	J	0.22324	J	0.18744	J	0.23697	J	0.19491	0.054	0.27139
Cadmium, dissolved			0.001	U	0.001	U	0.0033	J	0.0035	J	0.001	U	0.001	U	0.0026	J	0.001	U	0.0013	0.004	0.004
Cadmium, total	ND	0.005	0.001	U			0.00307	J	0.0041	J	0.001	U	0.001	U	0.0028	J	0.001	U	0.0015	0.0007	0.0142
Calcium			63.8283				65.27745		64.20603		64.86902		65.96515		64.52338		63.11859		64.5411	41.6	49.7
Calcium, dissolved			62.90637		64.28277		64.98514		65.02318		64.64879		65.34284		62.9878		62.80162		64.1223		
Chloride			78				88		78		83.97		82.97		80		80		81.5629	28.9	46.1
Chromium, dissolved			0.00214		0.002		0.00223		0.00209		0.00202		0.00209		0.00221		0.00208		0.00211	0.005	0.013
Chromium, total	ND	0.01	0.0028	J			0.00277	J	0.00309	J	0.00282	J	0.00276	J	0.00307	J	0.00282	J	0.00288	0.0018	0.01
Cobalt, dissolved			0.00577		0.00759		0.00847		0.00957		0.0073		0.00949		0.00621		0.00628		0.00759		
Cobalt, total			0.00832				0.00876		0.00847		0.00942		0.00672		0.00876		0.00869		0.00845	0.003	0.027
Copper, dissolved			0.0045	U	0.00484	U	0.01033	U	0.01289	U	0.01033	U	0.01307	U	0.004	U	0.00512	U	0.00407	0.003	0.0074
Copper, total	ND	0.025	0.01111	U			0.01064	U	0.01498	U	0.0158	U	0.01001	U	0.0103	U	0.01271	U	0.00611	0.002	0.0043
Dissolved oxygen			6.2		6.4		6.5		6.2		6.2		6.2		6.2		6.1		6.25		
Fluoride	0.7	0.2	0.7		0.7		0.7		0.7		0.6		0.6		0.7		0.6		0.65714	1.07	1.32
Iron, dissolved			0.069	U	0.069	U	0.069	U	0.069	U	0.069	U	0.069	U	0.069	U	0.069	U	0.0345	0.004	0.017
Iron, total			0.069	U			0.069	U	0.069	U	0.069	U	0.069	U	0.069	U	0.069	U	0.0345	0.01	0.169
Lead, dissolved			0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0005	0.001	0.002
Lead, total	ND	0.003	0.001	U			0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0005	0.001	0.002
Lithium, dissolved			0.04408	U	0.04446	U	0.04541	U	0.04646	U	0.04417	U	0.04608	U	0.04246	U	0.04532	U	0.0224		
Lithium, total			0.05143	U			0.04522	U	0.04627	U	0.0457	U	0.04436	U	0.04427	U	0.04704	U	0.02316	0.03314	0.055
Magnesium			20.40975				20.84635		20.4766		20.81502		21.09662		20.24404		20.12109		20.5728	11.4	13.9
Magnesium, dissolved			20.11028		20.53523		20.78437		20.80442		20.81424		21.00295		20.02069		19.80084		20.4841		
Manganese, dissolved			0.00343	U	0.00245	U	0.00232		0.00625	U	0.00698		0.00747		0.006		0.00551		0.00303	0.001	0.002
Manganese, total			0.00514				0.00245		0.00919		0.00845		0.01201		0.00723		0.00723		0.00739	0.001	0.0182

Notes:
Italic indicates Phase II mean value calculated using one-half the value of "U"d results.
Results are in mg/l unless otherwise noted
"U" data qualifier indicates reported value is "non detect" (ND).
"J" data qualifier indicates reported value is estimated.

Table 4.5-1A (continued)
Analysis Results for Water Samples Collected from IWW Ditch

Table 4.5-1A

Parameter	NEIC Sample		Phase II Samples																Mean of Phase II Samples	Well 125	
	NEIC 04IW		O307IWA		O307IWD		O307IWE		O307IWF		O307IWG		O307IWH		O307IWN		O307IWP			Range of Values(4/92-12/93)	
	Value Reported	Detection Limit	Value Reported	Data Qualifier	Value Reported	Data Qualifier	Value Reported	Data Qualifier	Value Reported	Data Qualifier	Value Reported	Data Qualifier	Value Reported	Data Qualifier	Value Reported	Data Qualifier	Value Reported	Data Qualifier			Minimum Value
Mercury, dissolved			0.00006	U	0.00006	U	0.0001	U	0.00007	U	0.00006	U	0.00006	U	0.0001	U	0.00009	U	3.8E-05		
Mercury, total	ND	0.0005	0.00011	U			0.00011	U	0.00009	U	0.00013	U	0.00009	U	0.00009	U	0.00011	U	5.2E-05	0.0002	0.00047
Molybdenum, dissolved			0.013	U	0.013	U	0.013	U	0.01395	U	0.013	U	0.01383	U	0.013	U	0.02427	U	0.00732		
Molybdenum, total			0.01803	U			0.01372	U	0.013	U	0.013	U	0.013	U	0.013	U	0.01565	U	0.0071	0.013	0.02
Nickel, dissolved			0.011	U	0.011	U	0.011	U	0.011	U	0.011	U	0.011	U	0.011	U	0.011	U	0.0055		
Nickel, total	ND	0.025	0.011	U			0.011	U	0.011	U	0.011	U	0.011	U	0.011	U	0.011	U	0.0055	0.007	0.02
Nitrate (NO3 as N)			1.25		1.37		1.21		1.21		1.13		1.24		1.26		1.13		1.225	0.47	0.77
Orthophosphate (PO4 as P)	0.58	0.02	0.312		0.48		0.428		0.633		0.385		0.383		0.338		0.3		0.40738	0.02	0.04
pH			8.8		8.9		8.7		8.7		8.8		8.8		8.5		9		8.775	7.27	8.42
Phosphorus, total	0.7	0.02	0.345		0.515		0.495		0.855		0.47		0.44		0.395		0.335		0.48125	0.02	0.34
Potassium			7.96479				8.23679		9.52707		8.12173		8.29607		7.89505		8.045		8.29807	5.9	12.3
Potassium, dissolved			7.81833		7.94387		8.19496		9.61424		8.20541		8.26469		7.79391		7.62304		8.18231		
Redox (mV)			120		77		103		98		81		81		101		101		95.25	40	153
Selenium, dissolved			0.002	U	0.002	U	0.002	U	0.002	U	0.002	U	0.002	U	0.002	U	0.002	U	0.001	0.002	0.002
Selenium, total	ND	0.005	0.002	U			0.002	U	0.002	U	0.002	U	0.002	U	0.002	U	0.002	U	0.001	0.001	0.0031
Silver, dissolved			0.004	U	0.004	U	0.004	U	0.004	U	0.004	U	0.004	U	0.004	U	0.004	U	0.002	0.003	0.005
Silver, total	ND	0.01	0.004	U			0.004	U	0.004	U	0.004	U	0.004	U	0.004	U	0.004	U	0.002	0.002	0.004
Sodium			58.10832				61.15139		54.90327		58.134		59.20499		57.1022		59.18787		58.256	47.6	57
Sodium, dissolved			57.36854		52.80345		60.13637		58.74538		58.89979		59.17864		56.88919		56.71009		57.5914		
Specific conductance, at 25 C (umhos/cm)			1351		592		644		684		200		200		696		712		634.875	414	567
Sulfate			75				75		78		72		80		77		69		75.1429	38	47
Temperature (° C)			22.2		18.5		22.1		23.3		24.2		24.2		18.7		19.9		21.6375	14.8	18.3
Thallium, total	ND	0.01	0.001	U			0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.001	U	0.0005	0.0005	0.004
Thallium, dissolved			0.001	U	0.001	U	0.001	U	0.001	U	0.00151		0.001	U	0.001	U	0.001	U	0.00063		
Total dissolved solids			490		400		490		430		410		440		460		1810		616.25	300	390
Total suspended solids			4	U	4	U	4	U	6	U	4	U	4	U	4	U	4	U	4.25		
Vanadium, dissolved			0.002	U	0.00212	U	0.00359	U	0.00429	U	0.00249	U	0.00475	U	0.002	U	0.00304	U	0.00152	0.0045	0.007
Vanadium, total			0.00442	U			0.00242	U	0.00412	U	0.00525	U	0.0023	U	0.00377	U	0.00515	U	0.00196	0.002	0.12
Zinc, dissolved			0.01866	U	0.01232	U	0.00999	U	0.00803	U	0.01408	U	0.00723	U	0.00677	U	0.00845	U	0.00535	0.003	0.0157
Zinc, total	ND	0.02	0.01503	U			0.01379	U	0.03087	U	0.01137	U	0.01964	U	0.01938	U	0.01835	U	0.00917	0.0051	0.065
Radiological Activities (pCi/l)																					
Gross alpha			2.12	UJ	2.3	UJ	0.05	U	0.74	U	1.71	U	3.42		-0.69	U	-0.13	U		1.26	3.7
Gross beta			4.83	U	5.17	U	4.94	U	5.71	U	4.62	U	5.53	U	5.1	U	6.09	U		4.44	10.2
Radium-226			0.89	U	0.31	U	0.46	U	0.79	U	0.18	U	0.63	U	0	U	0.18	U		0.16	1.5
Radium-228			-0.3	U	-2.9	U	-1.5	U	-0.3	U	6.5		-1.1	U	0	U	-0.7	U		0.4	1.7

Notes:

Italic indicates Phase II mean value calculated using one-half the value of "U"d results.

Results are in mg/l unless otherwise noted

"U" data qualifier indicates reported value is "non detect" (ND).

"J" data qualifier indicates reported value is estimated.

TABLE 4.5-2
MEAN METAL CONCENTRATIONS IN SPRING WATER (mg/l)

TABLE 4.5-2

Parameter	SPRING GROUP												Representative Groundwater Concentrations
	I - Batiste System		II - Swanson Road System	III - East Side System		IV - Papoose System							
	Batiste Spring	Batiste Springs Drainage	Swanson Road Spring	Springs near STP	Spring-fed Pond at FMC Park	Papoose Spring	Papoose Springs Drainage	Papoose Springs Drainage Channel	Papoose Springs Drainage Channel	Papoose Springs Discharge	Siphon Road Spring	Twenty Springs (East)	
	SW14	SW11	SW15	SW13	SW09	SW07	SW06	SW5F(a)	SW5E(a)	SW05	SW04	SW02	
Arsenic													0.0104 to 0.018
Total	0.015	0.006	0.007	0.003	0.003	0.003	0.004	0.002	0.004	0.004	0.003	0.004	
Dissolved	0.032	0.003	0.010	0.003	0.004	0.005	0.003	0.002	0.003	0.003	0.003	0.002	0.12 to 0.23
Barium													
Total	0.083	0.107	0.123	0.114	0.104	0.095	0.094	0.077	0.074	0.103	0.064	0.760	
Dissolved	0.061	0.086	0.114	0.112	0.089	0.075	0.081	0.079	0.076	0.089	0.062	0.063	0.25 to 0.308
Boron													
Total	0.19	0.21	0.28	0.24	0.10	0.19	0.10	ND	ND	0.09	0.08	0.10	
Dissolved	0.18	0.19	0.21	0.22	0.10	0.23	0.20	ND	ND	0.12	0.15	0.11	0.0165 to 0.0610
Lithium													
Total	0.051	0.034	0.044	0.036	0.023	0.031	0.033	ND	ND	0.036	0.038	0.037	
Dissolved	0.053	0.038	0.041	0.042	0.023	0.033	0.037	0.024	0.027	0.035	0.039	0.039	0.0745 to 0.199
Vanadium													
Total	0.018	0.029	0.026	0.013	0.030	0.032	0.023	ND	ND	0.024	0.006	0.006	
Dissolved	0.004	0.029	0.034	0.003	0.026	0.003	0.057	ND	ND	0.067	ND	ND	

Notes: (a) Sampled only in April 1993.
NA = not analyzed.
ND = not detected/below detection limit.

Reference:
Means for RI data calculated from four rounds of sampling: July and October 1992, and February and April 1993. Samples with results reported as below detection not used in calculation of individual station means. Station mean reported as ND if all sample results below detection.

TABLE 4.5-3
MEAN METAL CONCENTRATIONS IN RIVER WATER (mg/l)

TABLE 4.5-3

Parameter (units in mg/l)	Losing River Stations										River Station SW17	Gaining River Stations									Representative Groundwater Concentrations
	SW25	SW24	SW23	SW22	SW21	SW20	SW19	SW18(a)	SW16	Group Mean	SW17	SW12E(b)	SW12	SW10	SW08	SW7E(b)	SW03	SW01	Group Mean		
Aluminum																					
Total (4 events)	0.35	0.49	0.66	0.85	0.83	0.44	0.51	0.07	0.53	0.52	1.02	1.80	0.50	0.59	0.76	1.32	1.07	0.57	0.94	0.57 to 0.95	
Total (3 events)	0.17	0.16	0.22	0.30	0.30	0.12	0.17	0.07	0.13	0.18	ND	NS	0.10	0.17	0.44	NS	ND	0.02	0.18		
Total (Apr-93)	0.90	1.47	1.55	1.40	1.36	1.08	1.54	NS	1.73	1.38	1.02	1.80	0.90	1.00	1.09	1.32	1.07	1.13	1.19		
Dissolved	ND	0.08	ND	0.02	ND	ND	0.20	ND	0.10	0.10	ND	ND	0.10	0.15	0.16	ND	ND	0.03	0.11		
Arsenic																					
Total	0.004	0.005	0.004	0.006	0.005	0.007	0.007	0.007	0.007	0.006	0.006	0.005	0.005	0.003	0.003	0.003	0.006	0.005	0.004	0.0104 to 0.018	
Dissolved	0.004	0.004	0.003	0.003	0.003	0.006	0.003	ND	0.003	0.004	0.003	0.005	0.006	0.004	0.006	0.004	0.003	0.003	0.004		
Barium																					
Total	0.104	0.101	0.103	0.100	0.099	0.102	0.104	0.109	0.090	0.101	0.081	0.096	0.124	0.119	0.116	0.093	0.090	0.092	0.104	0.12 to 0.23	
Dissolved	0.092	0.094	0.094	0.093	0.088	0.099	0.104	0.108	0.095	0.096	0.096	0.076	0.096	0.100	0.102	0.078	0.082	0.137	0.096		
Boron																					
Total	0.33	0.22	0.23	0.12	0.11	0.13	0.25	0.12	0.19	0.19	0.38	ND	0.27	0.19	0.18	ND	0.14	0.16	0.19	0.25 to 0.308	
Dissolved	0.17	0.31	0.14	0.15	0.18	0.16	0.20	0.13	0.19	0.18	0.23	ND	0.20	0.20	0.17	ND	0.14	0.15	0.17		
Copper																					
Total	0.009	0.003	ND	ND	ND	ND	ND	ND	0.005	0.006	0.015	ND	0.007	ND	ND	ND	0.003	ND	ND	0.0085 to 0.013	
Dissolved	0.003	0.003	ND	0.003	ND	ND	0.022	ND	0.005	0.007	0.011	ND	0.003	0.004	0.004	ND	0.012	ND	0.006		

Notes: (a) SW18 sampled only during October 1992.
(b) Sampled only in April 1993.
NA = not analyzed.
ND = Not detected/below detection limit.
NS = Not sampled.

Reference: Means for RI data calculated from four rounds of sampling: July and October 1992, and February and April 1993. Samples with results reported as below detection not used in calculation of individual station means. Station mean reported as ND if all sample results below detection. Group mean reported as ND if 70 percent (All River and Losing Reach) to 60 percent (Gaining Reach) of station means below detection limits.

TABLE 4.5-3 (continued)
MEAN METAL CONCENTRATIONS RIVER WATER (mg/l)

TABLE 4.5-3

Parameter (units in mg/l)	Losing River Stations										River Station SW17	Gaining River Stations									Representative Groundwater Concentrations
	SW25	SW24	SW23	SW22	SW21	SW20	SW19	SW18 ^(a)	SW16	Group Mean	SW17	SW12E ^(b)	SW12	SW10	SW08	SW7E ^(b)	SW03	SW01	Group Mean		
Iron																					0.7690 to 1.074
Total (4 events)	0.50	0.54	0.63	0.43	0.54	0.33	0.61	0.07	0.54	0.47	0.41	1.73	0.38	0.31	0.34	1.32	0.42	0.40	0.70		
Total (3 events)	0.06	0.09	0.14	0.12	0.15	0.15	0.13	0.07	0.18	0.12	0.09	NS	0.08	0.07	0.11	NS	0.04	0.04	0.07		
Total (Apr-93)	0.94	1.46	1.61	1.37	1.34	1.13	1.56	NS	1.61	1.38	1.05	1.73	0.97	1.03	1.03	1.32	1.17	1.13	1.20		
Dissolved	0.06	0.09	ND	0.02	0.09	0.02	0.05	ND	0.03	0.05	0.09	ND	0.06	0.05	0.04	ND	0.04	0.04	0.05		
Lithium																					0.0165 to 0.061
Total	0.058	0.058	0.055	0.052	0.057	0.053	0.051	0.056	0.049	0.054	0.049	0.023	0.039	0.041	0.037	ND	0.039	0.043	0.037		
Dissolved	0.058	0.057	0.056	0.046	0.043	0.054	0.090	0.056	0.041	0.056	0.042	ND	0.045	0.041	0.037	0.021	0.041	0.038	0.037		
Manganese																					0.0201 to 0.1097
Total	0.020	0.023	0.025	0.021	0.027	0.020	0.027	0.008	0.024	0.022	0.023	0.057	0.018	0.018	0.017	0.046	0.019	0.016	0.027		
Dissolved	0.004	0.032	ND	0.002	ND	0.004	0.035	ND	0.004	0.013	0.005	0.001	0.005	0.004	0.004	0.001	0.002	0.004	0.003		
Vanadium																					0.0745 to 0.1987
Total	0.013	0.005	0.012	0.003	0.022	0.004	ND	0.004	0.037	0.013	0.027	ND	0.019	0.023	0.031	ND	0.005	0.017	0.019		
Dissolved	ND	ND	ND	ND	ND	0.002	0.016	ND	0.057	0.025	0.012	ND	0.070	0.047	0.079	ND	0.003	0.019	0.044		

Notes: ^(a) SW18 sampled only during October 1992.
^(b) Sampled only in April 1993.
NA = not analyzed.
ND = Not detected/below detection limit.
NS = Not sampled.

Reference: Means for RI data calculated from four rounds of sampling: July and October 1992, and February and April 1993. Samples with results reported as below detection not used in calculation of individual station means. Station mean reported as ND if all sample results below detection. Group mean reported as ND if 70 percent (All River and Losing Reach) to 60 percent (Gaining Reach) of station means below detection limits.

TABLE 4.5-4
MEAN CONCENTRATIONS OF COMMON IONS, PHYSICAL PARAMETERS, AND NUTRIENTS AND FLUORIDE IN SPRING WATER

TABLE 4.5-4

Parameter	I - Batiste System			II - Swanson Road System		III - East Side System			IV - Papoose System							Representative Groundwater Concentration	
	System Mean	Batiste Spring	Batiste Springs Drainage	System Mean	Swanson Road Spring	System Mean	Springs near STP	Spring-fed Pond at FMC Park	System Mean	Papoose Spring	Papoose Springs Drainage	Papoose Spring Drainage Channel	Papoose Springs Discharge	Siphon Road Spring	Twenty Springs (East)		
	1978-80 ^(a)	1992-93 ^(a)	1992-93 ^(a)	1978-80 ^(a)	1992-93 ^(a)	1978-80 ^(a)	1992-93 ^(a)	1992-93 ^(a)	1978-80 ^(a)	1992-93 ^(a)	1992-93 ^(a)	April 1993 ^(b)		1992-93 ^(a)	1992-93 ^(a)		1992-93 ^(a)
	Perry et al. (1990)	SW14	SW11	Perry et al. (1990)	SW15	Perry et al. (1990)	SW13	SW09	Perry et al. (1990)	SW07	SW06	SW5E	SW5F	SW05	SW04		SW02
Common Ions																	
Alkalinity, bicarbonate, mg/l	233.3	211	222	290.2	286	264.4	278	357	201.1	252	205	190	204	211	181	186	171 to 307
Calcium, mg/l	101.3	69.5 (78.7)	58.0 (64.1)	79.5	92.7 (98.5)	70.2	64.6 (67.9)	59.7 (63.7)	60.5	57.1 (61.2)	57.5 (61.4)	59.4	57.8	59.0 (63.3)	54.0 (58.1)	54.4 (58.4)	68.75 to 97.7
Chloride, mg/l	55.7	40.2	27.9	40.3	49.3	26.8	27.5	21.7	20.9	17.9	18.8	17.0	20.0	26.5	15.2	15.5	52.4 to 192.9
Magnesium, mg/l	34.4	26.6	22.5	27.8	33.5	27	27.5	25.8	21.4	20.1	19.9	19.8	20.9	22.4	16.9	16.9	19.2 to 35.9
Potassium, mg/l	9.5	8.79	5.84	6.7	7.37	6.2	6.97	6.50	5.4	4.15	4.26	3.66	3.91	5.28	3.54	3.53	7.34 to 12.7
Sodium, mg/l	53.6	52.9	42.7	41.4	55.7	36.1	54.4	37.2	23.4	23.8	23.4	21.0	23.6	31.2	20.3	20.6	27.5 to 74.3
Sulfate, mg/l	≈150	113	51	≈40	104	≈55	55	45	≈45	38	39	39	39	43	38	39	43.4 to 72.6
Physical Parameters																	
Specific conductance, μmhos/cm	946.3	773	609	732.5	907.7	638.5	747.0	658.5	515.7	495.7	495.7	519	535	565.3	469.0	458.3	569 to 1,136
pH, units		7.3	7.8		7.3		7.3	7.5		7.8	7.8	8.0	8.2	7.8	7.7	7.8	
Temperature, °C		13.9	14.4		13.6		17.1	17.5		14.3	14.6	12.4	13.4	14.0	16.3	16.4	
Total dissolved solids, mg/l		465	360		540		415	350		300	293	260	330	320	290	313	
Total suspended solids, mg/l		ND	9		ND		6.0	4.0		ND	ND	NM	NM	ND	22.0	21.0	
Nutrients and Fluoride																	
Ammonia (NH ₃ as N), mg/l	6.19	ND	0.3	0.05	0.4	0.22	ND	ND	0.08	0.5	ND	ND	ND	0.4	ND	ND	0.5
Nitrate (NO ₃ as N), mg/l	5.58	4.44	1.99	2.54	2.64	2.1	3.41	2.30	1.43	2.98	2.14	2.47	2.56	2.15	1.40	1.47	1.60 to 5.52
Orthophosphate (PO ₄ as P), mg/l	1.9	2.36	0.59	0.04	0.99	0.1	0.04	0.03	0.03	0.03	0.03	0.03	ND	0.24	0.04	0.03	0.06 to 0.27
Phosphorus, total, mg/l	2.06	2.71	0.48	0.07	1.05	0.14	0.05	0.04	0.07	ND	0.04	0.05	ND	0.22	0.07	0.09	0.15 to 0.33
Fluoride, mg/l	0.44	0.6	0.6	0.3	0.5	0.42	0.3	0.4	1.32	0.5	0.6	0.6	0.5	0.5	0.8	0.7	0.41 to 0.80
Dissolved oxygen, mg/l		6.5	9.9		4.7		8.0	9.9		8.0	8.9	8.2	9.4	7.5	6.5	7.7	

Notes: (a) Sampling dates.
(b) Sampling date was April 1993. Numbers indicate one round of sampling, not a mean.
ND = not detected/below detection limit.

Reference: Means for RI data calculated from four rounds of sampling: July and October 1992, and February and April 1993; except calcium value in parentheses calculated from October 1992, February 1993, and April 1993 data only. Samples with results reported as below detection not used in calculation of means. Mean reported as ND if all sample results below detection.

TABLE 4.5-5
MEAN CONCENTRATIONS OF COMMON IONS, PHYSICAL PARAMETERS, AND NUTRIENTS AND FLUORIDE IN RIVER WATER

TABLE 4.5-5

Parameter	Losing River Stations										River Station SW17	Gaining River Stations									Representative Groundwater Concentrations
	SW25	SW24	SW23	SW22	SW21	SW20	SW19	SW18(a)	SW16	Group Mean		SW17	SW12E	SW12	SW10	SW08	SW7E	SW03	SW01	Group Mean	
Common Ions																					
Alkalinity, bicarbonate, mg/l	250	253	248	248	231	257	249	284	246	252	188	22.4	268	251	251	21.2	246	241	251	171 to 307	
Calcium, mg/l	62.0 (72.3)	61.6 (71.9)	62.9 (72.6)	53.4 (65.2)	55.8 (65.8)	65.9 (73.7)	65.7 (75.0)	69.8 (69.8)	65.5 (72.1)	62.5 (70.9)	62.2 (67.6)	69.1	70.2 (75.3)	66.1 (72.9)	65.5 (70.3)	63.9	66.0 (70.1)	65.1 (69.1)	66.6 (71.5)	68.75 to 97.7	
Chloride, mg/l	46.7	48.1	47.7	45.5	42.8	46.5	45.7	56.3	46.5	47.3	54.6	32.0	49.0	43.5	38.5	33.0	40.9	39.6	42.3	52.4 to 192.9	
Magnesium, mg/l	32.4	31.1	32.2	30.6	28.9	32.7	32.0	37.2	30.5	32.0	22.6	25.3	30.6	27.9	27.4	23.5	26.8	26.1	27.8	19.2 to 35.9	
Potassium, mg/l	9.57	8.95	9.23	8.77	8.50	9.43	8.73	10.80	8.45	9.16	8.36	5.66	9.12	7.92	7.49	5.62	7.50	7.21	7.85	7.34 to 12.7	
Sodium, mg/l	41.0	41.6	41.7	40.2	43.5	41.5	39.7	48.1	41.1	42.1	47.7	29.8	55.1	48.6	42.7	32.3	47.1	51.2	49.0	27.5 to 74.3	
Sulfate, mg/l	50	38	42	42	38	43	41	46	45	42.9	65	41	70	60	54	49	58	57	59.8	43.4 to 72.6	
Physical Parameters																					
Specific conductance, µmhos/cm	730.3	707.3	702.7	677.3	647.7	696.0	631.0	875.0	678.7	705	738.0	614	775.7	667.3	685.3	617	673.7	642.3	689	569 to 1,136	
pH, units	8.5	8.4	8.4	8.4	8.5	8.7	8.3	8.6	8.2	8.5	8.5	8.0	7.5	7.7	7.9	7.9	7.6	7.7	7.7		
Temperature, °C	17.0	15.6	15.6	15.9	17.2	14.7	17.3	12.4	13.8	15.5	17.6	11.5	14.9	14.1	16.2	10.9	16.3	15.8	15.5		
Total dissolved solids, mg/l	403	393	380	347	300	405	380	NM	400	376	403	350	460	420	425	340	410	393	422		
Total suspended solids, mg/l	9.0	12.0	14.0	17.0	52.0	22.0	15.0	NM	9.0	19	5.0	NM	6.5	6.0	28.0	NM	4.0	4.0	10		
Nutrients																					
Ammonia (NH3 as N), mg/l	ND	0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.4	1.2	0.9	ND	0.8	0.8	1.4	0.5	
Nitrate (NO3 as N), mg/l	0.64	0.68	0.59	0.65	0.42	0.60	0.66	0.31	0.82	0.60	1.29	1.23	2.09	1.91	1.93	0.82	2.14	2.26	2.07	1.60 to 5.52	
Orthophosphate (PO4 as P), mg/l	0.03	0.03	0.05	0.03	0.03	0.03	0.03	ND	0.07	0.04	0.32	0.34	0.97	0.45	0.39	0.38	0.48	0.45	0.55	0.06 to 0.27	
Phosphorus, total, mg/l	0.09	0.09	0.09	0.08	0.16	0.06	0.13	0.02	0.15	0.10	0.64	0.47	1.05	0.49	0.43	0.48	0.52	0.45	0.59	0.15 to 0.33	
Fluoride, mg/l	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.7	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.41 to 0.80	
Dissolved oxygen, mg/l	12.7	9.1	9.1	9.2	9.9	9.3	9.5	10.4	9.4	9.8	9.3	7.3	8.5	7.4	7.8	10.2	7.4	9.2	8.1		

Notes: (a) Sampled only in October 1992.
ND = Not detected/below detection limit.
NM = Not measured.

Reference: Means for RI data calculated from four rounds of sampling: July and October 1992, and February and April 1993; except calcium value in parentheses calculated from October 1992, and February and April 1993 data only. Samples with results reported as below detection not used in calculation of means. Mean reported as ND if all sample results below detection.

TABLE 4.5-6
RADIOLOGICAL ACTIVITIES IN SPRING WATER (pCi/l)

TABLE 4.5-6

Parameter (pCi/l)	SPRING GROUP											
	I - Batiste System		II - Swanson Road System	III - East Side System		IV - Papoose System						
	Batiste Spring	Batiste Springs Drainage	Swanson Road Spring	Springs near STP	Spring-fed Pond at FMC Park	Papoose Spring	Papoose Springs Drainage	Papoose Springs Drainage Channels	Papoose Springs Discharge	Siphon Road Spring	Twenty Springs (East)	
	SW14	SW11	SW15	SW13	SW09	SW07	SW06	SW05F	SW05E	SW05	SW04	SW02
Gross alpha												
Jul-92	2.30±1.50	2.20±1.40	ND	ND	2.60±1.60	2.00±1.30	2.10±1.30	NS	NS	ND	ND	ND
Oct-92	2.22±0.50	2.31±0.50	ND	2.66±0.57	2.66±0.50	ND	ND	NS	NS	ND	ND	ND
Feb-93	2.97±1.67	2.32±1.89	3.51±1.62	2.86±1.54	5.55±1.73	ND	ND	NS	NS	2.73±1.64	ND	3.26±1.71
Apr-93	ND	3.50±1.17	2.21±0.91	2.90±1.27	3.11±0.93	8.84±2.30	6.58±1.51	ND	2.06±0.84	2.59±1.15	ND	ND
Gross beta												
Jul-92	6.10±1.70	5.50±1.70	8.00±1.80	7.10±1.50	7.30±1.80	4.20±1.60	3.90±1.60	NS	NS	4.40±1.60	3.30±1.50	4.90±1.60
Oct-92	7.63±0.63	5.56±0.58	6.10±1.70	6.42±0.58	5.63±0.52	3.20±1.70	2.70±1.50	NS	NS	5.50±1.90	2.80±1.60	4.60±1.80
Feb-93	6.41±1.00	4.98±1.11	7.37±1.18	5.14±1.15	7.10±1.01	3.11±0.98	2.89±0.97	NS	NS	4.83±1.17	3.39±0.87	2.83±0.83
Apr-93	11.00±3.55	7.23±1.46	ND	6.43±1.41	5.69±1.33	±13.70±4.70	20.40±4.59	3.96±1.40	6.65±1.48	7.99±3.47	4.92±1.30	6.93±3.52
Radium-226												
Jul-92	ND	ND	ND	ND	ND	1.72±0.25	ND	NS	NS	ND	ND	ND
Oct-92	ND	2.60±0.40	1.82±0.25	ND	ND	ND	ND	NS	NS	5.20±0.26	ND	ND
Feb-93	ND	ND	1.50±0.62	ND	ND	1.93±0.33	ND	NS	NS	1.72±0.58	ND	ND
Apr-93	ND	ND	ND	ND	ND	1.40±0.38	ND	ND	ND	ND	ND	ND
Radium-228												
Jul-92	ND	ND	1.3±0.5	ND	ND	ND	ND	NS	NS	ND	ND	ND
Oct-92	ND	ND	2.2±1.0	ND	ND	1.4±0.9	1.7±0.9	NS	NS	ND	3.5±0.9	3.2±1.0
Feb-93	ND	ND	ND	1.4±0.9	ND	1±0.8	ND	NS	NS	ND	ND	5.3±1.2
Apr-93	ND	ND	ND	ND	ND	ND	ND	2.1±0.8	2.8±1.2	1.1±0.8	ND	ND
Uranium-233/234												
Jul-92	NA	NA	NA	NA	NA	NA	NA	NS	NS	NA	NA	NA
Oct-92	NA	NA	NA	NA	NA	NA	NA	NS	NS	NA	NA	NA
Feb-93	1.08±0.27	NA	NA	1.67±0.52	NA	NA	NA	NS	NS	1.19±0.32	NA	NA
Apr-93	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes: NA = Not analyzed
ND = Not detected/below detection limit.
NS = Not sampled.

TABLE 4.5-7
RADIOLOGICAL ACTIVITIES IN RIVER WATER (pCi/l)

TABLE 4.5-7

Parameter (pCi/l)	Losing River Stations									River Station SW17	Gaining River Stations						
	SW25	SW24	SW23	SW22	SW21	SW20	SW19	SW18	SW16	SW17	SW12E	SW12	SW10	SW08	SW07E	SW03	SW01
Gross alpha																	
Jul-92	ND	ND	ND	2.60±1.60	ND	ND	2.70±1.70	NS	3.00±1.60	ND	NS	ND	2.20±1.40	2.50±1.50	NS	2.50±1.70	2.10±1.60
Oct-92	ND	ND	ND	ND	ND	2±1.5	2.70±1.80	ND	ND	ND	NS	2.86±0.69	2.45±0.63	4.27±0.60	NS	ND	ND
Feb-93	4.93±2.00	2.03±1.52	2.60±1.84	3.31±1.58	NS	3.60±1.96	4.34±2.04	NS	2.61±1.94	3.69±1.54	NS	3.78±1.21	3.04±1.49	3.22±1.34	NS	3.60±1.55	3.22±1.19
Apr-93	2.20±0.94	ND	6.55±1.48	2.59±1.11	ND	ND	2.37±0.90	NS	ND	ND	2.53±1.13	2.04±1.36	10.80±2.10	3.09±0.93	2.30±1.24	2.63±0.87	2.87±1.02
Gross beta																	
Jul-92	8.10±1.30	6.90±1.80	8.40±1.30	9.60±1.30	6.60±1.20	7.00±1.20	9.10±1.30	NS	6.90±1.80	9.90±1.90	NS	7.30±1.80	4.00±1.60	5.70±1.70	NS	6.40±1.80	12.00±2.00
Oct-92	9.80±1.80	7.10±1.70	9.30±1.80	7.90±1.70	9.30±1.80	7.7±1.7	9.80±1.80	9.40±1.80	8.40±1.80	5.80±1.60	NS	9.04±0.67	10.70±0.78	9.47±0.66	NS	6.60±2.00	4.20±1.60
Feb-93	8.67±1.23	9.05±1.24	7.08±1.37	7.43±1.23	NS	8.21±1.42	7.89±1.41	NS	7.41±1.22	7.68±1.15	NS	8.05±1.02	7.97±1.28	7.40±1.02	NS	8.80±1.16	7.10±0.81
Apr-93	ND	ND	13.80±4.31	ND	ND	11.10±3.87	ND	NS	ND	ND	3.41±1.74	10.10±4.64	8.71±3.57	8.39±1.42	5.20±1.45	6.80±1.44	5.96±1.35
Radium-226																	
Jul-92	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	NS	ND	ND	ND	NS	3.11±0.27	ND
Oct-92	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	NS	ND	ND
Feb-93	ND	2.91±0.78	ND	ND	NS	ND	ND	NS	ND	1.19±0.50	NS	ND	ND	ND	NS	1.15±0.49	ND
Apr-93	1.31±0.38	ND	ND	ND	ND	ND	ND	NS	ND	1.14±0.36	ND	ND	ND	ND	ND	ND	1.00±0.34
Radium-228																	
Jul-92	ND	ND	7.5±0.8	ND	1.2±0.5	1.9±0.9	ND	NS	ND	ND	NS	ND	ND	ND	NS	ND	ND
Oct-92	2.1±1.1	2.3±1.0	3.2±1.0	ND	1.5±0.9	1.7±0.9	2.0±1.0	2.2±1.0	ND	ND	NS	ND	ND	ND	NS	5.9±2.2	2.1±0.9
Feb-93	ND	ND	ND	ND	NS	3.4±0.9	ND	NS	ND	ND	NS	ND	ND	ND	NS	ND	ND
Apr-93	3.3±0.8	ND	1.6±0.8	ND	1.2±0.7	ND	ND	NS	1.6±0.8	ND	2.0±0.8	1.1±0.8	ND	ND	1.2±0.9	1.8±1.0	ND
Uranium-233/234																	
Jul-92	NA	NA	NA	NA	NA	NA	NA	NS	NA	NA	NS	NA	ND	NA	NS	NA	NA
Oct-92	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NS	NA	NA	NA	NS	NA	NA
Feb-93	1.26±0.29	1.39±0.29	NA	1.40±0.35	NS	NA	NA	NS	NA	1.12±0.47	NS	NA	1.23±0.30	NA	NS	NA	1.36±0.51
Apr-93	NA	NA	NA	NA	NA	NA	NA	NS	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes: NA = Not analyzed.
ND = Not detected/below detection limit.
NS = Not sampled.

Section 4 Nature and Extent of Constituents of Potential Concern

TABLE 4.5-8
PERCENTAGE OF GROSS BETA ACCOUNTED FOR BY POTASSIUM-40

Station ID	Sampling Round			
	Jul-92	Oct-92	Feb-93	Apr-93
1	52.5	162.3	96.0	77.8
2	60.9	68.5	108.4	40.7
3	102.5	107.1	81.3	69.9
4	92.9	109.5	93.0	56.8
5	83.3	106.9	75.9	59.9
5E	NS	NS	NS	46.9
5F	NS	NS	NS	84.1
6	107.0	132.5	123.8	15.6
7	89.3	114.5	115.1	23.1
8	95.7	81.0	99.0	60.5
9	82.9	93.8	74.4	97.4
10	117.2	82.8	103.7	59.4
11	102.2	75.1	94.1	74.9
12	95.7	88.6	93.1	85.2
12E	NS	NS	NS	141.4
13	90.0	95.6	111.1	85.8
14	92.2	75.9	90.4	115.9
15	82.0	111.7	84.4	ND
16	98.8	106.5	112.7	ND
17	83.5	123.4	102.1	ND
18	NS	97.9	NS	NS
19	78.6	95.6	110.1	ND
20	126.6	102.9/106.7	103.8	39.3
21	118.8	100.8	NS	ND
22	82.5	115.4	113.5	ND
23	109.5	98.9	121.5	32.2
24	125.9	127.2	92.3	ND
25	126.2	94.8	99.3	ND

Notes: All results given in %.
 ND = Not detected/below detection limit.
 NS = Not sampled.

TABLE 4.5-9
METAL CONCENTRATION IN RIVER SEDIMENTS

TABLE 4.5-9

Parameter (mg/kg)	Upstream River Stations											River Station SW17	Downstream River Stations										Background
	SD25 (clayey sand)	SD24 (clay)	SD23 (clay)	SDA2 (silty clay)	SDA1 (silty clay)	SD22 (silty clay)	SD21 (silt and sand)	SD20 (sand w/ silt and gravel)	SD19 (silty clay)	SD18 (sand w/ gravel)	SD16 (silty clay)	SD17 (sandy clay)	SD12 (sand)	SD10 (fine sand)	SD08 (loam)	SD03 (loam, sand, and gravel)	SD01 (loam)	SDB1 (silty clay)	SDC1 (silt w/ fine sands)	SDC2 (silt w/ fine sands)	SDC4 (silt w/ fine sands)	Soil EPA	
Aluminum, total	4850	10400	11400	11200 J	14600 J	5230	4450	2100	8560	3690	9010	7830	3810	2500	5200	3670	4260	16200 J	5320 J	8760 J	6790 J	13,900	
Arsenic, total	4.1	4.1	3.5	5.5	5.7	3.4	3.6	ND	2.7	8.4	3.0	3.7	3.7	2.4	9.9	3.1	4.4	6.2	6.5	4.6	6.1	7.7	
Barium, total	174	122	113	123 J	145 J	112	87.3	130	144	109 J	123 J	165 J	108 J	68.7 J	95.8 J	71.7 J	95.6 J	183 J	118 J	122 J	106 J	188	
Beryllium, total	0.21	0.65	0.41	0.62	0.81	0.10	ND	ND	ND	ND	0.80	0.73	1.10	0.35	1.50	ND	0.79	0.89	0.32	0.50	0.32	1	
Boron, total	4.1	4.3	6	12.2	13.2	5.2	3	3.5	4.6	2.5	2.7	3.3	3.2	4.0	4.9	4.2	5.7	15.2	ND	13.1	12.6	12.8	
Cadmium, total	ND	ND	ND	ND	ND	ND	ND	ND	1.6	ND	ND	22.2	ND	ND	ND	ND	ND	ND	ND	1	0.95	1.9	
Chromium, total	9.2	18.1	19.4	17.2	18.9	10.6	12.4	5.6	22.4	9.6 J	23.8 J	80.8 J	8.2 J	12.1 J	16.6 J	12.4 J	9.7 J	25.0	11.7	19.0	16.2	27.5	
Cobalt, total	5.5	4.5	5.8	5.2	6.4	3.7	4.9	4.4	4.8	ND	ND	ND	ND	ND	ND	ND	ND	6.4	3.6	4.4	3.1	7.6	
Copper, total	12.1	11.6	12.8	11.6	14.8	10.6	10.8	9.8	12.7	7.1 J	30.8 J	85.9 J	9.6 J	4.8 J	9.2 J	6.4 J	8.3 J	25.5	6.3	12.9	9.7	12.6	
Iron, total	7730	10400	11400	10900 J	14400 J	7890	7850	4970	8530	5270 J	10100 J	7770 J	6090 J	5130 J	7020 J	7280 J	6530 J	16100 J	6010 J	8910 J	6920 J		
Lead, total	26.0 J	51.6 J	71.9 J	12.1	13.9	13.8	12.8	61.0 J	38.6 J	12.4 J	17.6 J	21.3 J	9.8 J	6.7 J	19.2 J	9.2 J	22.9 J	30.9	8.1	9.2	8.9	29.1	
Lithium, total	6.7	12.4	14.1	12.5 J	15.8 J	7.2	6.0	3.7	10.6	4.5	9.2	7.2	5.0	4.0	6.7	3.8	5.7	21.8 J	7.7 J	12.1 J	8.3 J	16.1	
Manganese, total	522 J	365 J	216 J	229 J	399 J	277 J	300 J	342 J	237 J	170 J	163 J	1210 J	425 J	99.9 J	97.6 J	136 J	120 J	238 J	202 J	161 J	140 J	482	
Mercury, total	ND	ND	ND	ND	0.55	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.1	ND	ND	ND	0.16	
Molybdenum, total	ND	ND	ND	ND	ND	ND	2.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.15	
Nickel, total	6.7	7.6	7.3	11.8	13.9	5.9	4.0	2.7	6.4	4.8	6.9	12.1	4.8	ND	6.5	4.8	ND	16.1	7.3	9.7	7.8	15.5	
Selenium, total	0.72	0.54	ND	ND	ND	ND	ND	ND	1.20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.36	
Silver, total	ND	ND	ND	ND	ND	ND	ND	3.0	ND	ND	1.7	4	2.2	1.4	1.2	0.44	2.1	ND	1.3	ND	ND	1.9	
Thallium, total	ND	ND	ND	ND	ND	0.14 J	ND	0.17	0.18	0.30 J	0.73 J	0.53 J	0.14 J	0.2 J	0.24 J	R	0.28 J	ND	ND	ND	ND	0.27	
Vanadium, total	32.1	28.8	30.7	18.1	21.4	25.1	23.1	24.2	32.3	19.9	25.3	87.8	18.8	15.6	30.6	14.6	21.9	23.9	10.5	17.5	13.9	45.4	
Zinc, total	24.3	42.9	48.1	50.3 J	55.3 J	32.7	40.1	ND	50.3	ND	56.9 J	251.0 J	27.0 J	27.4 J	39.4 J	31.8 J	25.6 J	97.1 J	30.2 J	50.1 J	41.3 J	52.8	

Notes: Units in mg/kg.
J = Estimated value.
ND = Not detected/below detection limit.
R = Rejected value.

TABLE 4.5-10
CONCENTRATIONS OF NUTRIENTS AND OTHER PARAMETERS IN RIVER SEDIMENTS

TABLE 4.5-10

PARAMETER	UPSTREAM RIVER STATIONS											RIVER STATION SW17	DOWNSTREAM RIVER STATIONS									
	SD25 (clayey sand)	SD24 (clay)	SD23 (clay)	SDA2 (silty clay)	SDA1 (silty clay)	SD22 (silty clay)	SD21 (silt and sand)	SD20 (sand w/ silt and gravel)	SD19 (silty clay)	SD18 (sand w/ gravel)	SD16 (silty clay)	SD17 (sandy clay)	SD12 (sand)	SD10 (fine sand)	SD08 (loam)	SD03 (loam, sand, and gravel)	SD01 (loam)	SDB1 (silty clay)	SDC1 (silt w/ fine sands)	SDC2 (silt w/ fine sands)	SDC4 (silt w/ fine sands)	
Calcium	NA	NA	NA	49100 J	36500 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	69300 J	166000 J	88500 J	93200 J	
Magnesium	NA	NA	NA	5020 J	5510 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8370 J	5610 J	5830 J	4920 J	
Orthophosphate (PO4 as P)	2.0	2.5	0.9	3.3	6.1	0.7	0.6	0.5	0.4	0.9	ND	1.7	1.2	2.4	ND	4.0	0.7	10.7	5.6	2.1	2.8	
Total Phosphorus	158	375	314	521	531	369	231	204	640	471	554	5340	479	7150	577	227	1310	493	1160	707	1060	
Fluoride	193	241	1300	390	460	500	198	149	338	240	273	3080	189	420	237	220	443	505	550	410	340	
pH	7.2	7.6	8.1	7.58	7.66	7.8	8.1	8.0	7.5	7.9	7.4	7.3	7.6	8.0	7.3	6.9	7.8	7.68	7.69	7.80	7.79	
Total Organic Carbon	NA	NA	NA	7995	9729	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	11074	8967	4495	9468	

Notes: ^(a) Units in mg/kg except for pH.
J = Estimated value.
NA = Not analyzed.

TABLE 4.5-11
METAL CONCENTRATIONS IN SPRING SEDIMENTS

TABLE 4.5-11

Parameter	Spring Group									Background Soil EPA	
	I - Batiste System		II - Swanson Road System	III - East Side System		IV - Papoose System					
	Batiste Spring	Batiste Springs Drainage	Swanson Road Spring	Springs near STP	Spring-Fed Pond at FMC Park	Papoose Spring	Papoose Springs Drainage	Papoose Springs Discharge	Siphon Road Spring		Twenty Spring (East)
	SD14 (sand and gravel)	SD11 (clayey sandy gravel)	SD15 (sand w/ silt)	SD13 (sand)	SD09 (loam)	SD07 (clayey sandy gravel)	*	SD05 (silty clay)	SD04 (loam)		SD02 (silty clay)
Aluminum, total	8230	3350	2970	2630	8600	2530	NS	6720	4150	5770	13,900
Arsenic, total	5.1	ND	1.7	1.5	7.6	9.1	NS	5.1	8.2	13.8	7.7
Barium, total	324 J	55.8 J	85.3 J	77.9	134 J	52.1 J	NS	93.5 J	83.2 J	86.3 J	188
Beryllium, total	0.79	ND	0.71	0.35	1.40	0.74	NS	0.84	ND	2.20	1
Boron, total	3.7	4.1	4.0	3.4	4.6	5.6	NS	5.9	5.0	ND	12.8
Cadmium, total	0.35	ND	ND	1.5	0.37	ND	NS	ND	ND	ND	1.9
Chromium, total	14.1 J	13.5 J	9.0 J	15.2	12.9 J	11.5 J	NS	15.1 J	20.6 J	54.0 J	27.5
Cobalt, total	ND	ND	ND	2.1	ND	ND	NS	ND	ND	ND	7.6
Copper, total	13.0 J	6.8 J	8.1 J	6.8	7.8 J	5.3 J	NS	9.3 J	7.5 J	11.8 J	12.6
Iron, total	6850 J	8524 J	6620 J	5530	9710 J	7760 J	NS	8220 J	5920 J	10400 J	
Lead, total	29.5 J	5.9 J	12.8 J	24.7 J	8.7 J	7.6 J	NS	50.5 J	7.3 J	ND	29.1
Lithium, total	9.1	5.1	3.9	3.9	9.9	4.0	NS	8.4	6.9	4.8	16.1
Manganese, total	117 J	75.1 J	405 J	116 J	281 J	52 J	NS	100 J	56 J	22.7 J	482
Mercury, total	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	0.16
Molybdenum, total	ND	ND	ND	ND	ND	ND	NS	ND	ND	ND	2.15
Nickel, total	7.6	5.2	4.1	2.5	6.6	5.1	NS	6.0	ND	ND	15.5
Selenium, total	ND	ND	ND	3.50	ND	ND	NS	ND	ND	ND	1.36
Silver, total	0.20	0.60	2.1	ND	1.1	0.17	NS	0.75	0.47	ND	1.9
Thallium, total	R	R	0.14 J	ND	0.14	R	NS	0.30 J	R	R	0.27
Vanadium, total	20.7	21.6	20.5	28.0	24.3	17.4	NS	26.2	25.2	192	45.4
Zinc, total	18.5 J	107.0 J	15.4 J	23.5	27.8 J	25.1 J	NS	54.3 J	31.4 J	37.4 J	52.8

Notes: Units in mg/kg.
J = Estimated Value
ND = Not detected/below detection level.
NS = Not sampled.
R = Rejected value.
* = Not assigned.

TABLE 4.7-7
PM₁₀ CONSTITUENTS
SAMPLING STATION 2

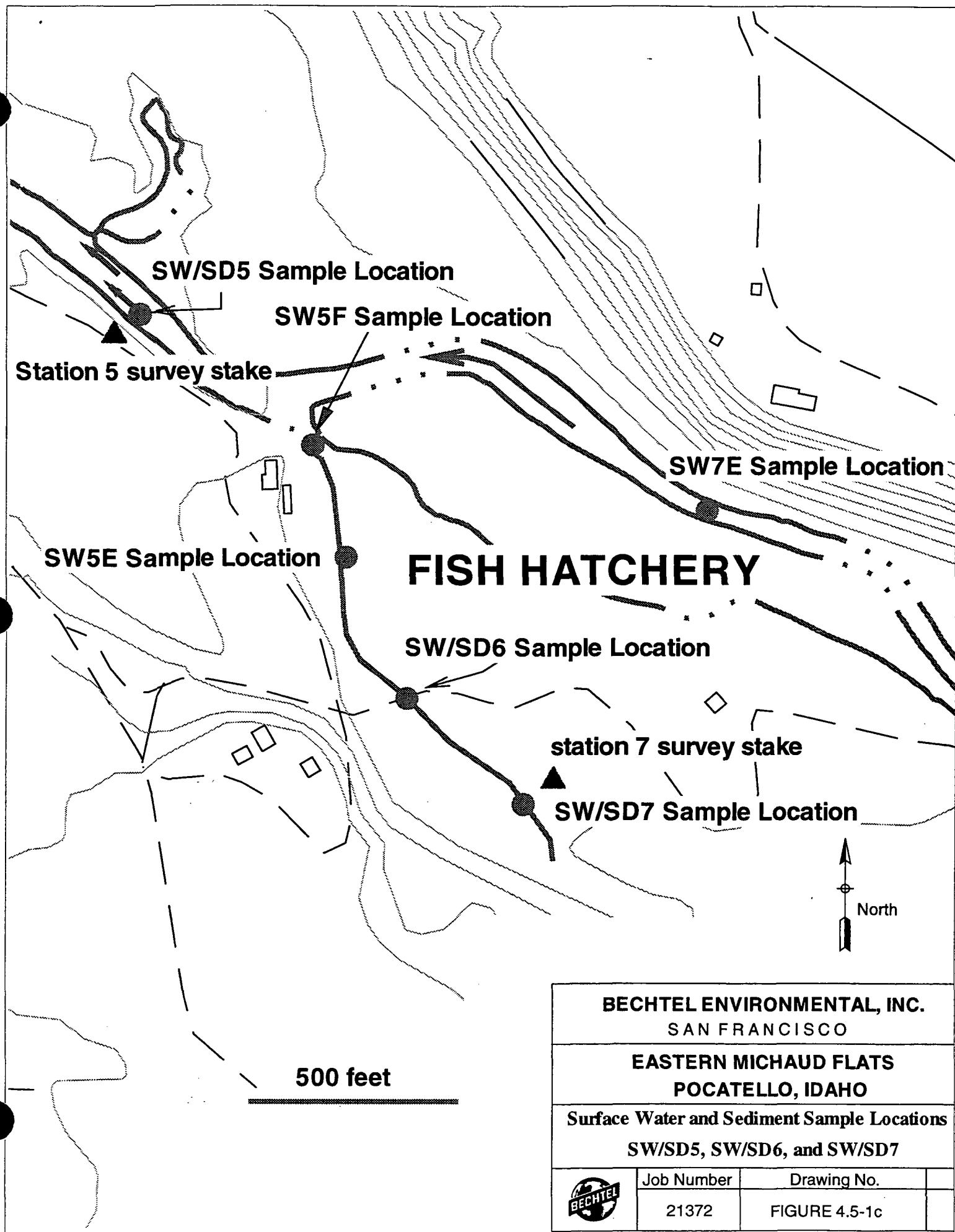
Station 2				Background (Station 6)	
Analyte	Detection Frequency	Range of Detected Values	Arithmetic Mean	Arithmetic Mean	95th Percentile
METALS ($\mu\text{g}/\text{m}^3$)					
Arsenic	44 / 45	1.80E-04 - 4.61E-03	1.29E-03	4.42E-04	1.45E-03
Cadmium	40 / 45	1.38E-03 - 5.60E-02	1.17E-02	7.00E-04	1.11E-03
Chromium (Total)	45 / 45	2.23E-03 - 1.19E-01	1.76E-02	1.34E-04	6.58E-04
Chromium VI			1.76E-04		
Nickel	19 / 36	3.23E-03 - 2.25E-02	4.15E-03	1.71E-03	3.20E-03 M
Phosphorus	44 / 45	7.45E-01 - 1.91E+01	5.53E+00	3.34E-02	2.03E-01
Vanadium	44 / 45	1.63E-03 - 1.26E-01	1.96E-02	8.96E-04	1.71E-03
Zinc	45 / 45	1.50E-02 - 4.16E-01	8.07E-02	4.67E-03	1.13E-02
RADIONUCLIDES (pCi/m³)					
Lead-210	42 / 45	5.97E-03 - 7.46E-02	2.44E-02	2.35E-02	5.41E-02
Polonium-210	42 / 43	2.28E-03 - 3.51E-01	7.31E-02	6.33E-03	2.05E-02
Radium-226	1 / 45	8.48E-04	2.78E-04	3.32E-04	3.33E-03 M
Thorium-230	25 / 38	2.01E-04 - 1.50E-03	2.94E-04	1.75E-05 U	1.75E-05 U
Uranium	41 / 45	1.95E-04 - 5.29E-03	8.01E-04	1.12E-05	4.41E-04 M

U = all nondetected values

M = only one detected concentration, detected value shown

Note: Highlighting indicates that the value is exceeded by the arithmetic mean measured at the site.

Note: Site 2 was located for purposes of model validation and is not representative of residential exposure. It does not comply with EPA's Monitoring Guidelines (EPA-450/4-87-007, May 1987) or with EPA's Guidelines for Exposure Assessment, 57 Federal Register 22888 (May 29, 1992). The data presented here thus do not represent "ambient air" 40 C.F.R. Section 50.1(e), worker exposure, or residential exposure.



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Surface Water and Sediment Sample Locations
SW/SD5, SW/SD6, and SW/SD7

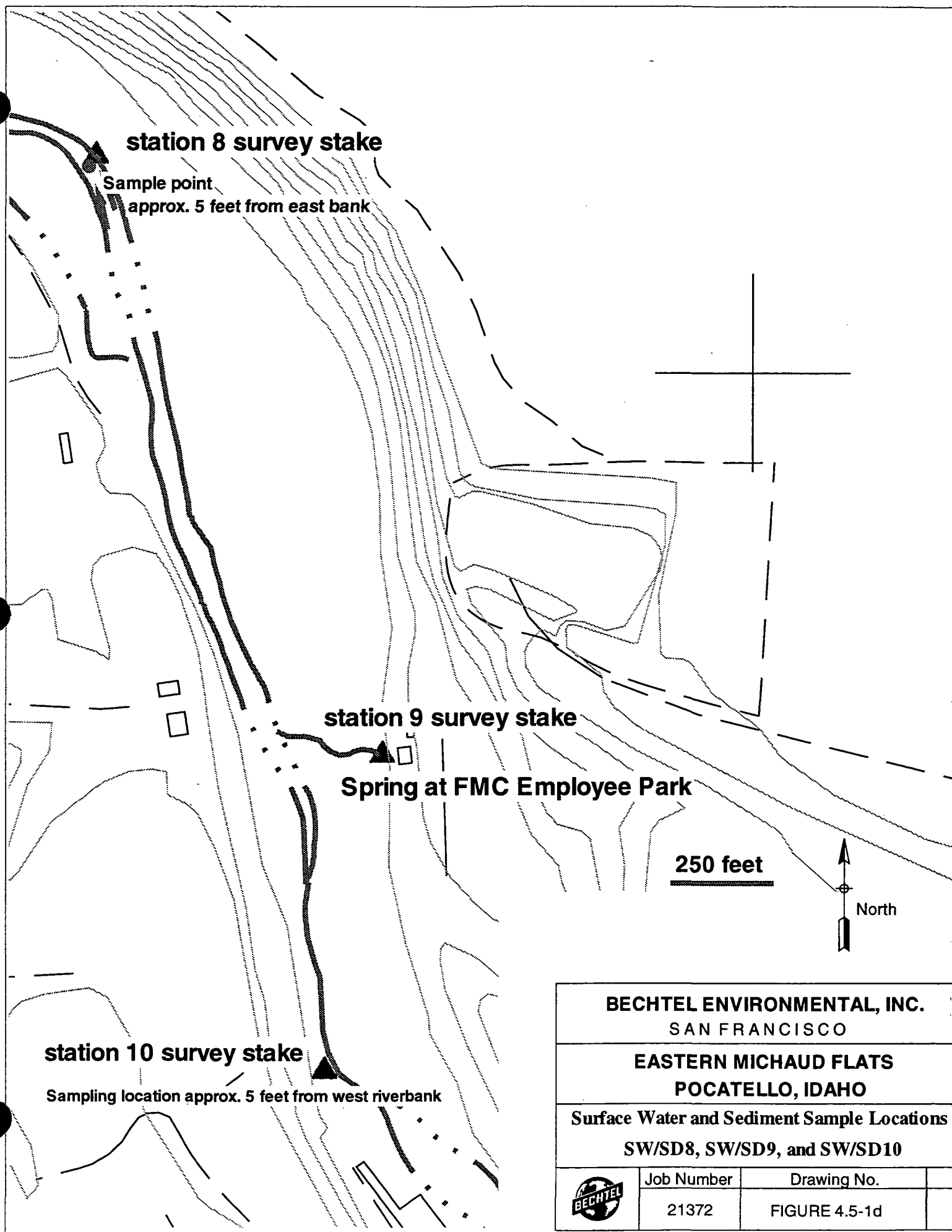


Job Number

Drawing No.

21372

FIGURE 4.5-1c



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Surface Water and Sediment Sample Locations
SW/SD8, SW/SD9, and SW/SD10

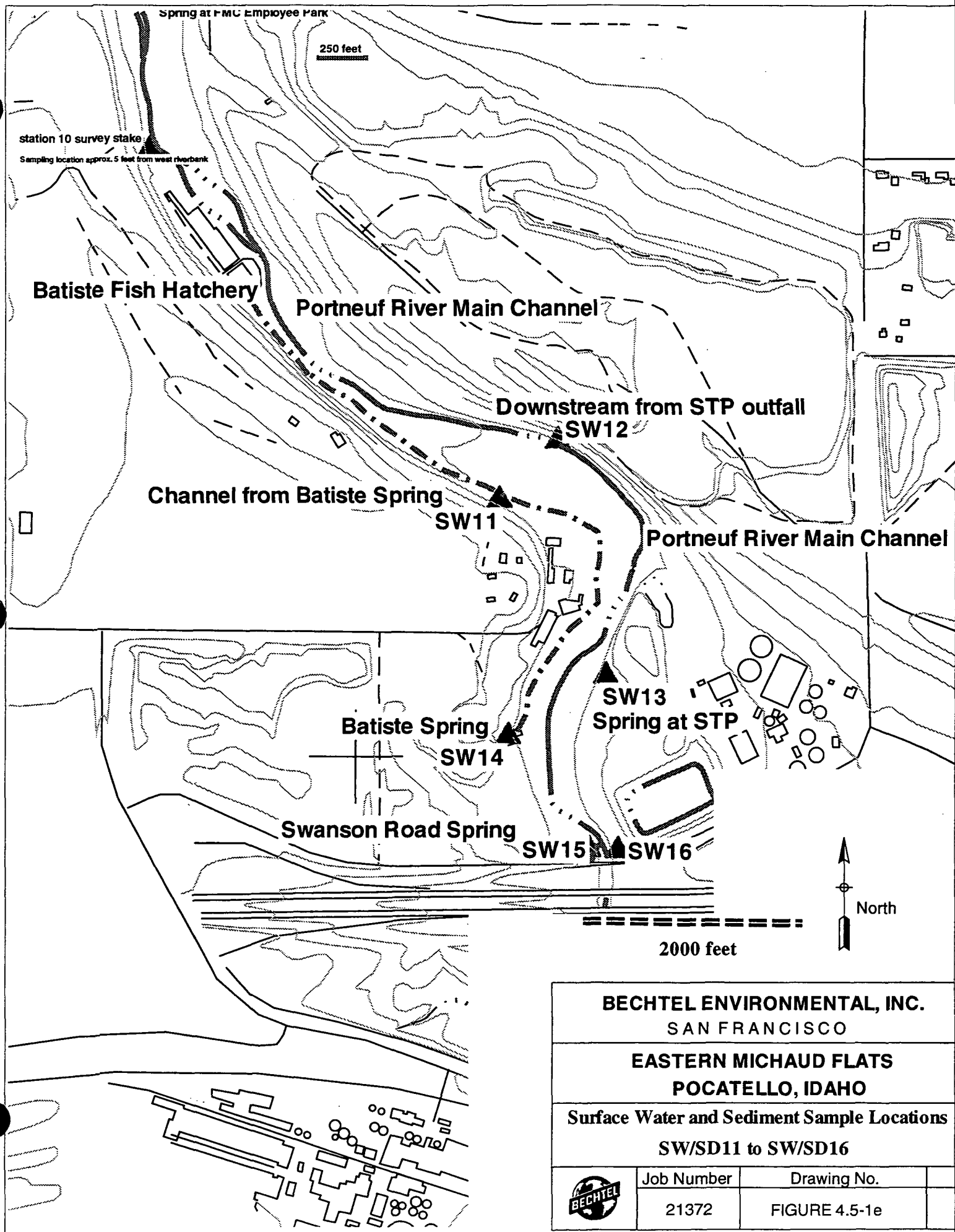


Job Number

21372

Drawing No.

FIGURE 4.5-1d



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Surface Water and Sediment Sample Locations
SW/SD11 to SW/SD16



Job Number

21372

Drawing No.

FIGURE 4.5-1e

station 17 survey stake

IWW Outfall

▲ station 18 survey stake

Portneuf River

station 19 survey stake

sample location

station 20 survey stake

North

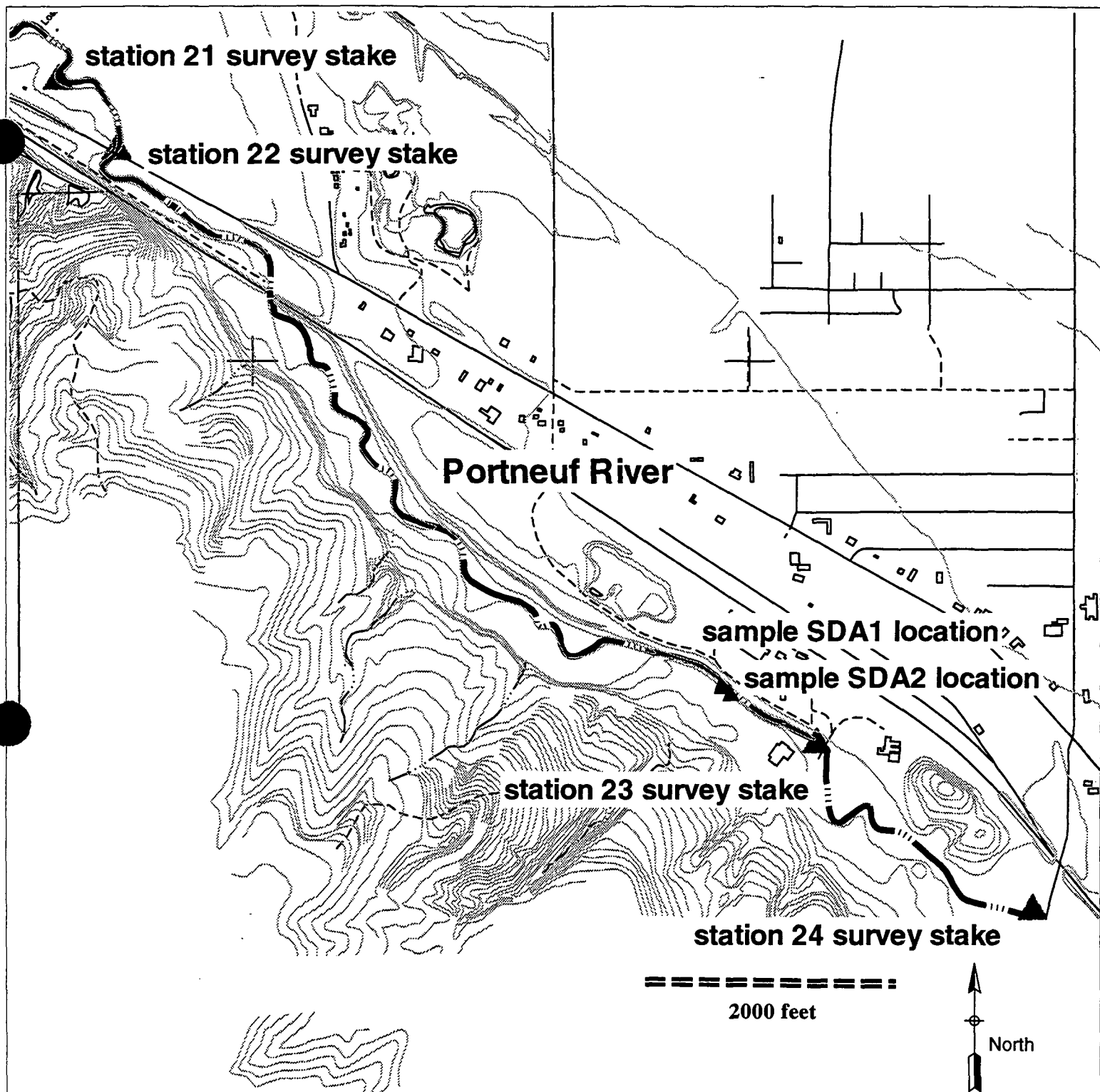
Former East
Overflow PondBECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCOEASTERN MICHAUD FLATS
POCATELLO, IDAHOSurface Water and Sediment Sample Locations
SW/SD17, SW/SD18, SW/SD19, and SW/SD20

Job Number

Drawing No.

21372

FIGURE 4.5-1f



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Surface Water and Sediment Sample Locations
SW/SD21, SW/SD22, SW/SD23, SW/SD24



Job Number

21372

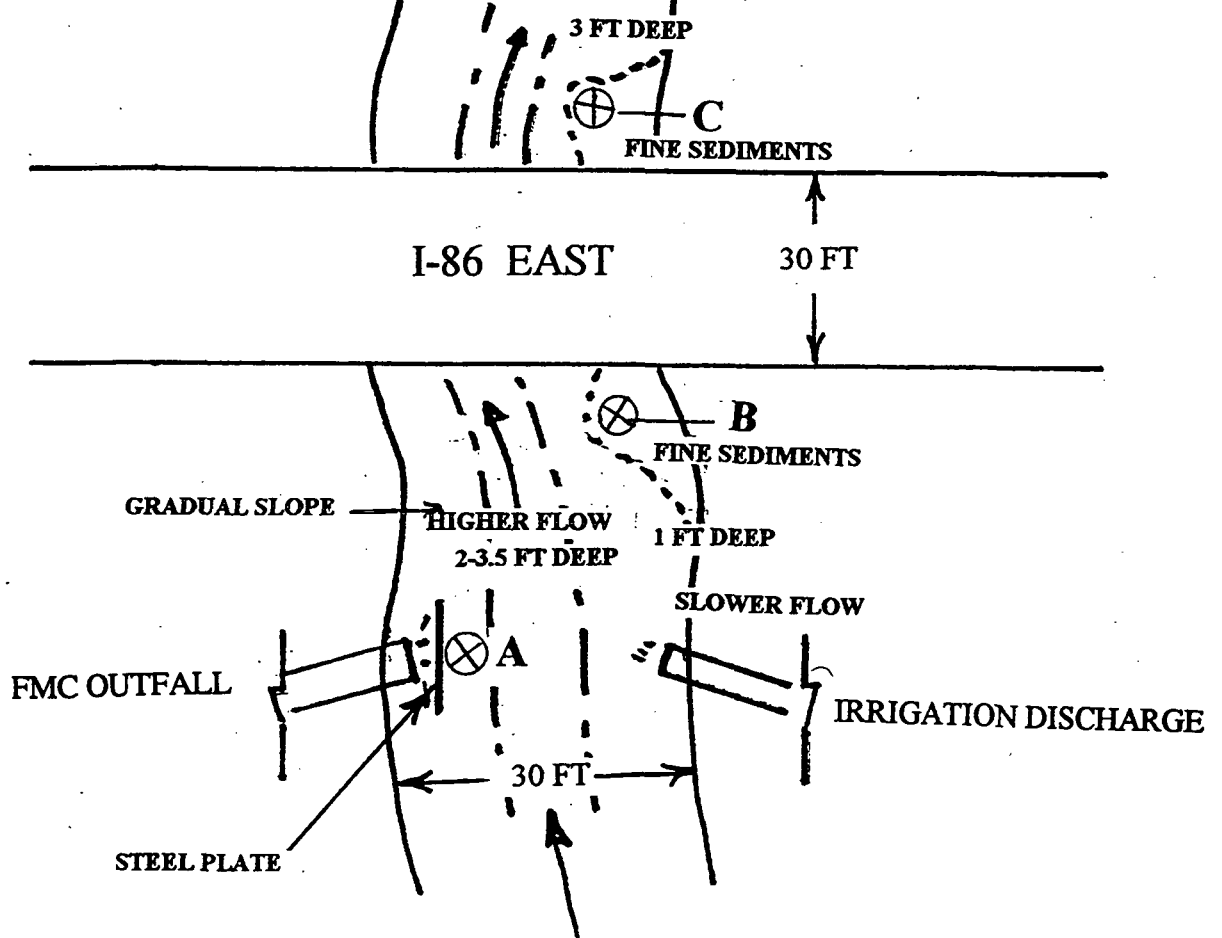
Drawing No.

FIGURE 4.5-1g

PORTNEUF RIVER

I-86 WEST

I-86 EAST



NOT TO SCALE



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Locations of Phase II FMC
Outfall Samples



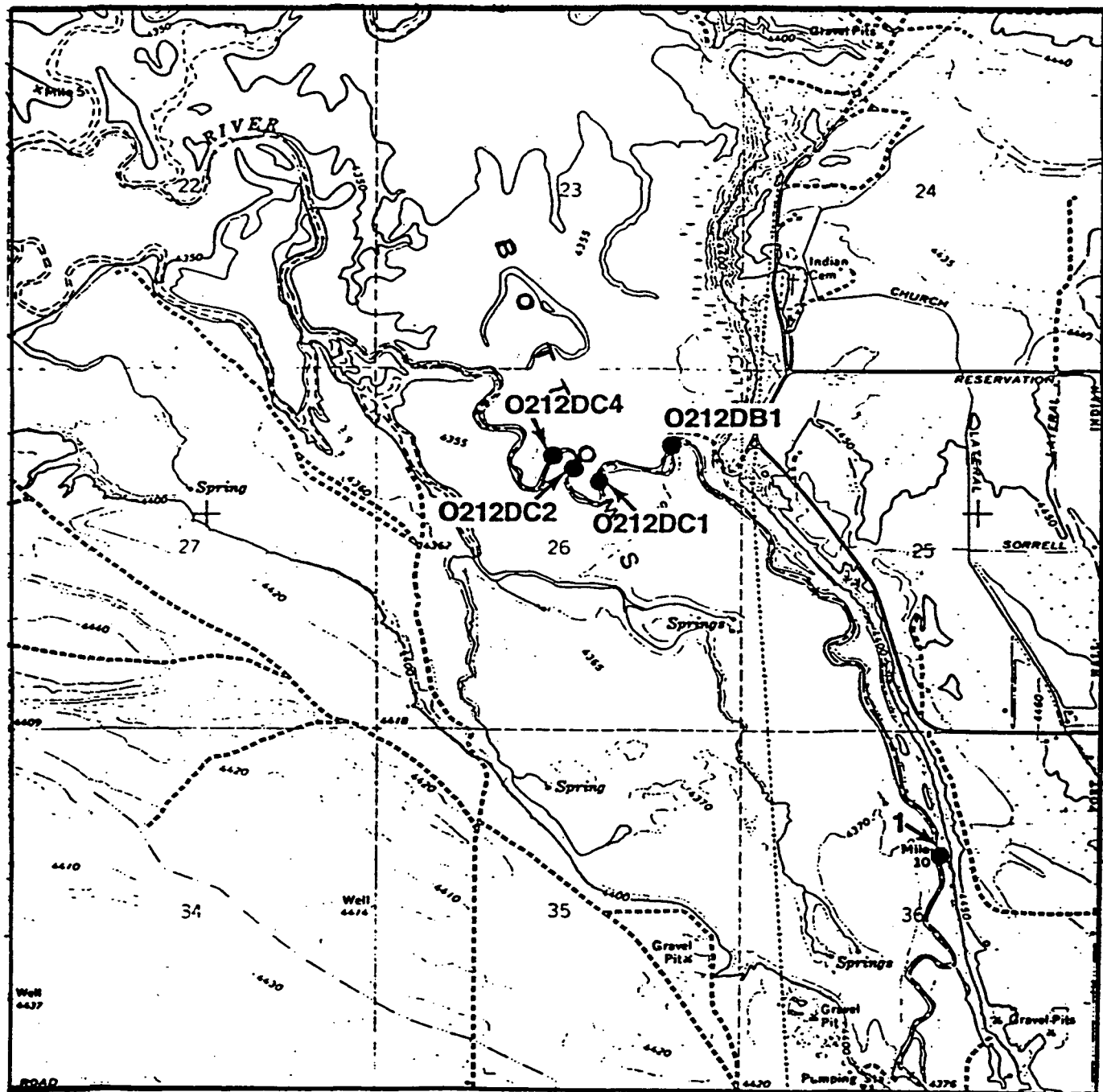
JOB No.

DRAWING NO.

REV.

21372

FIGURE 4.5-1h



SCALE 1:24 000



CONTOUR INTERVAL 10 FEET



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Sediment Samples Taken in the
Fort Hall Bottoms



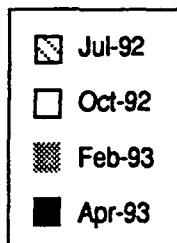
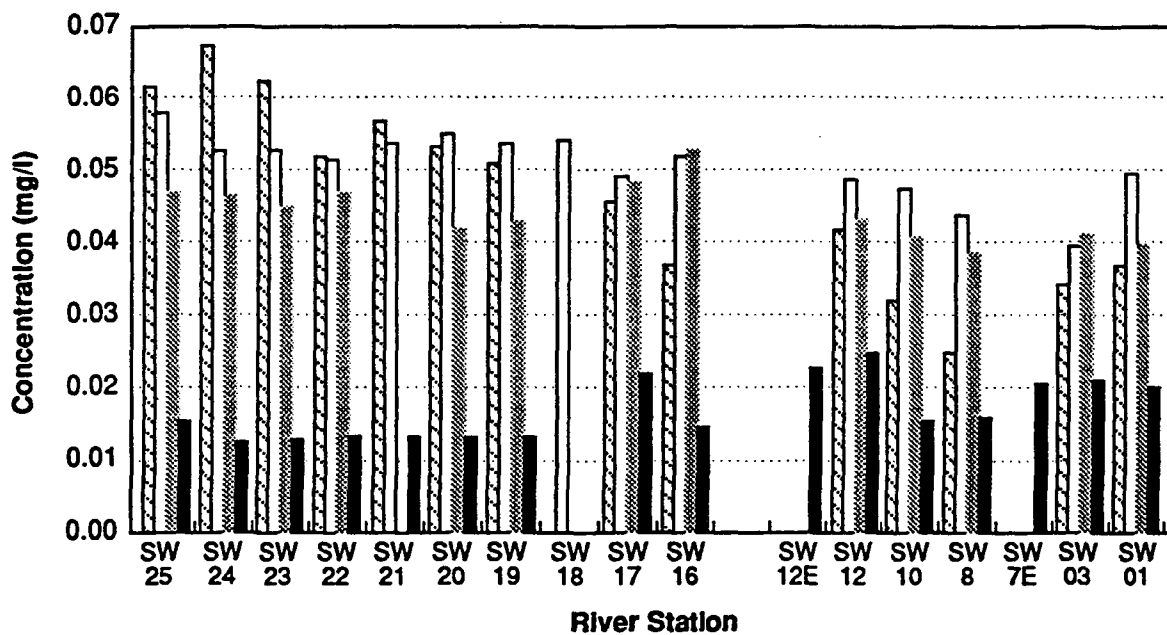
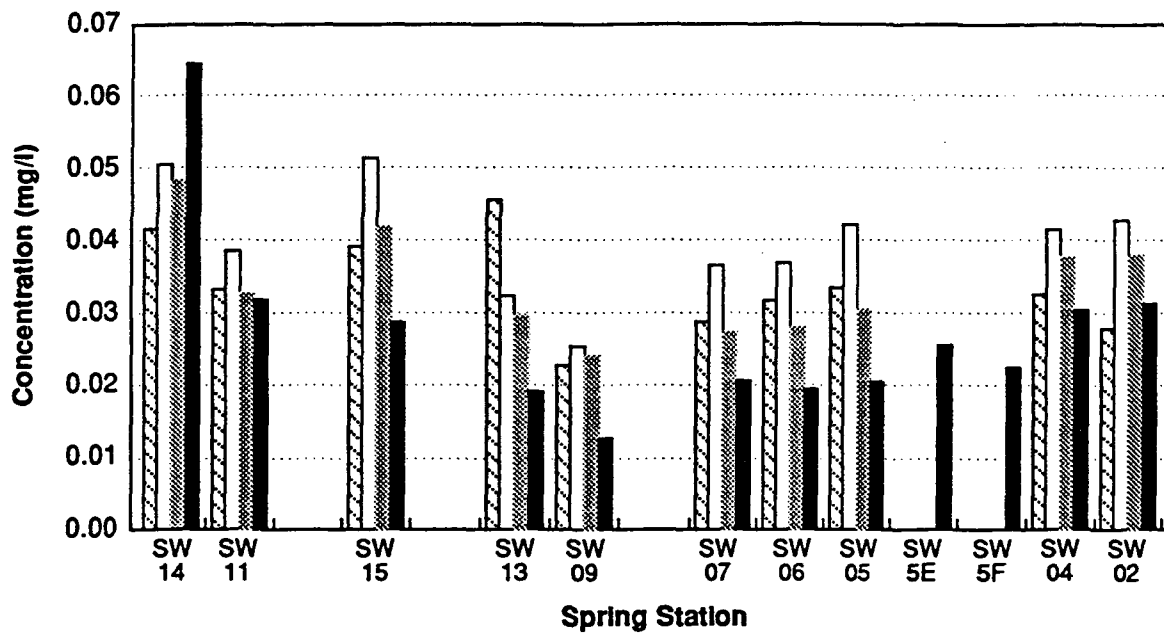
JOB No.

DRAWING NO.

REV.

21372

FIGURE 4.5-1i



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Lithium Concentrations in Surface
Water at Springs and River Stations



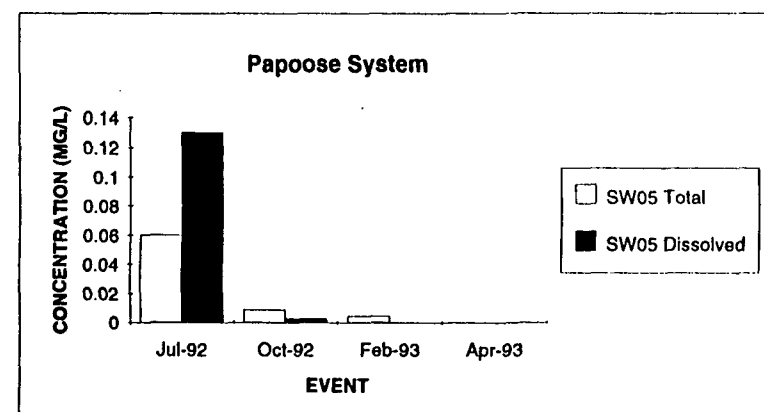
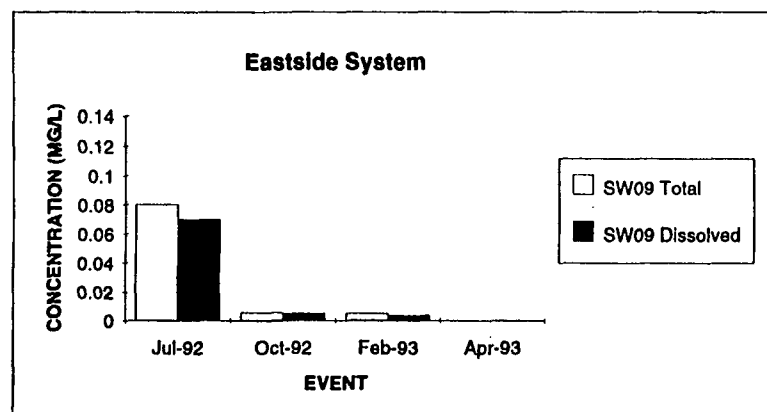
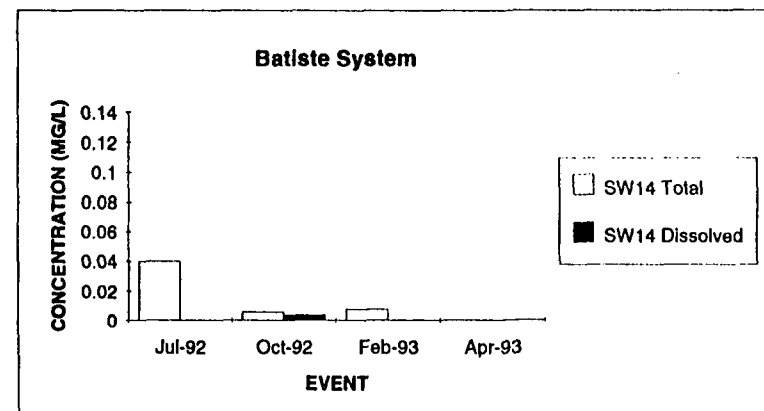
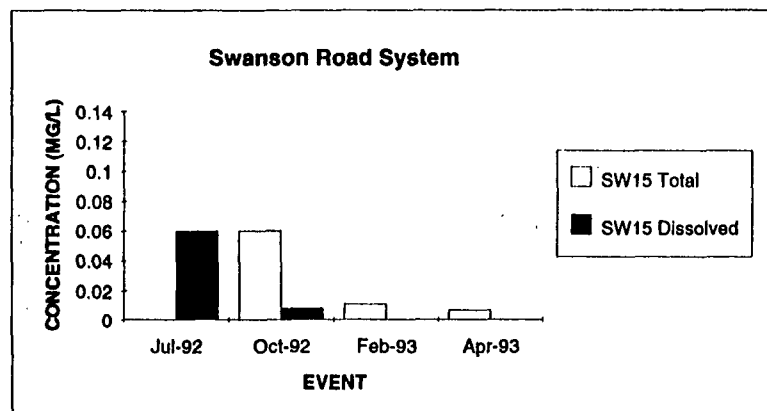
JOB No.

21372


DRAWING NO.

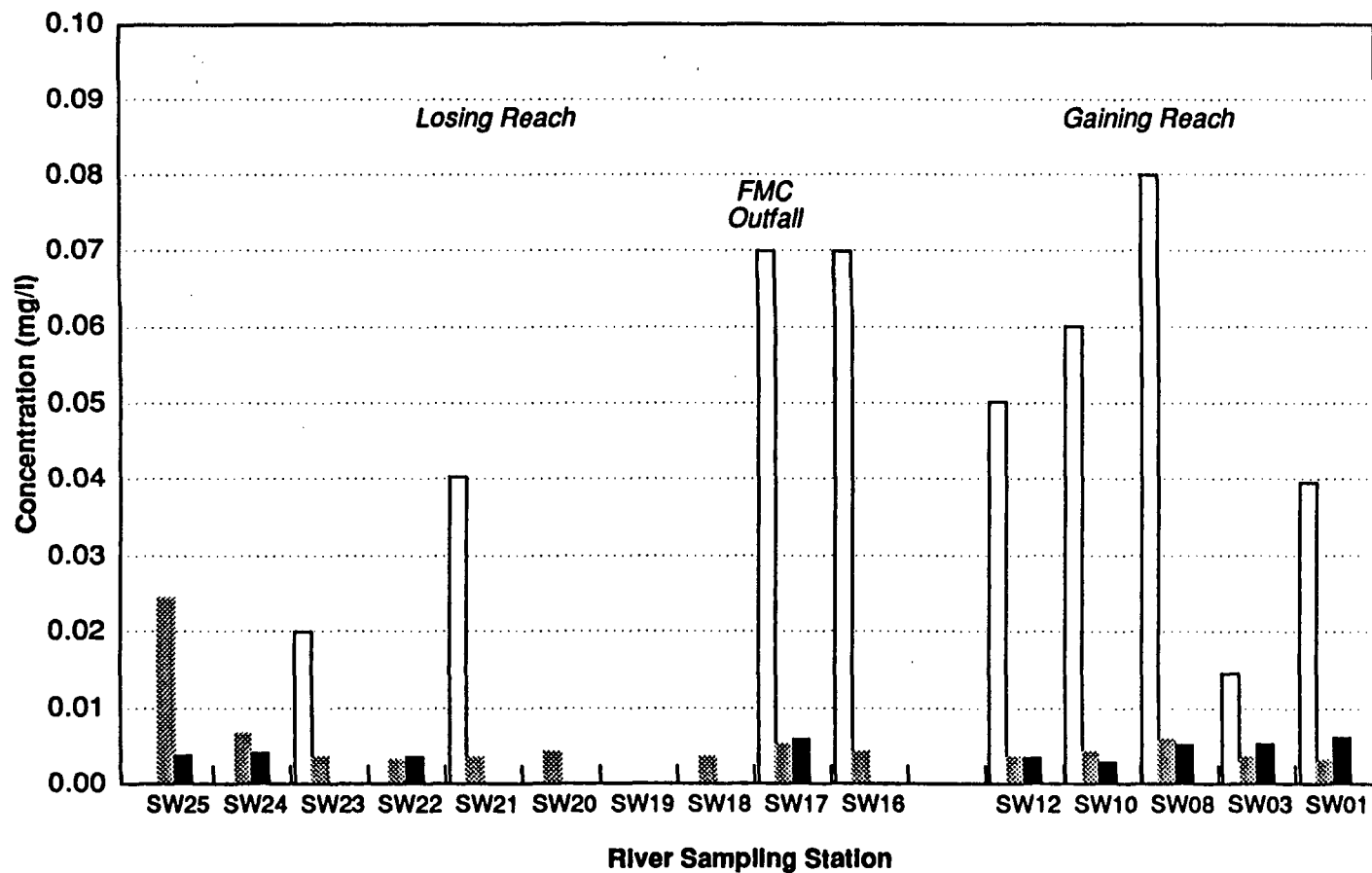
FIGURE 4.5-3

REV.



Note: Concentrations are not denoted in this figure for samples in which results were reported as not detected.

BECHTEL ENVIRONMENTAL, INC. SAN FRANCISCO			
EASTERN MICHAUD FLATS POCATELLO, IDAHO			
Vanadium Concentrations for Each Spring System			
	JOB No.	DRAWING NO.	REV.
	21372	FIGURE 4.5-4	0



- ☐ Jul-92 Sampling Event
- ☒ Oct-92 Sampling Event
- ☒ Feb-93 Sampling Event
- ☐ Apr-93 Sampling Event (non-detect)

Direction of Stream Flow →

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Vanadium Concentrations in Surface Water
Samples from River Sampling Stations



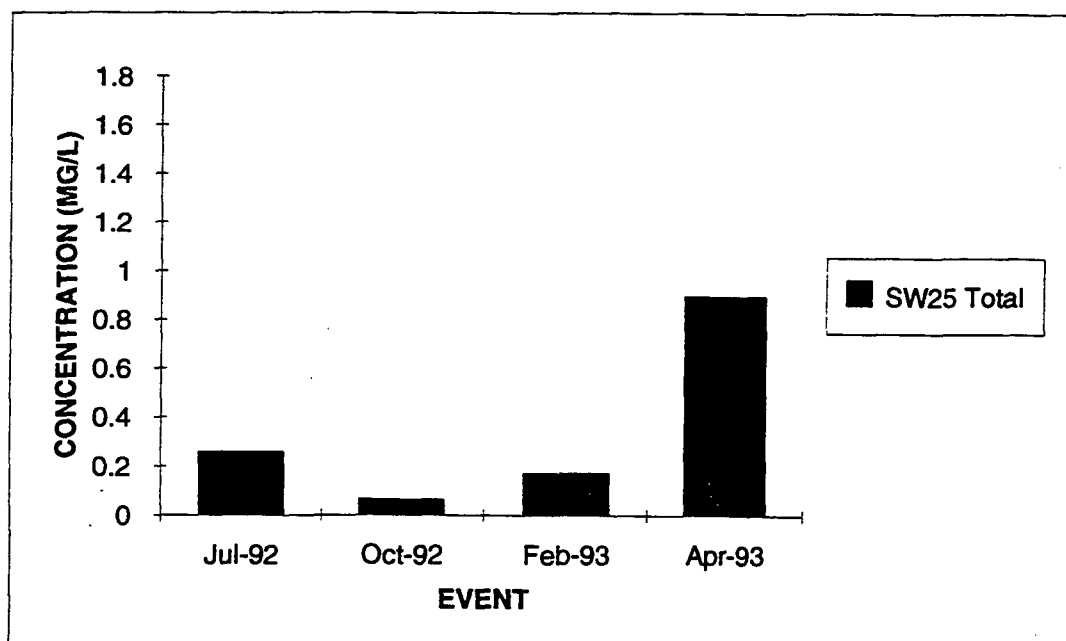
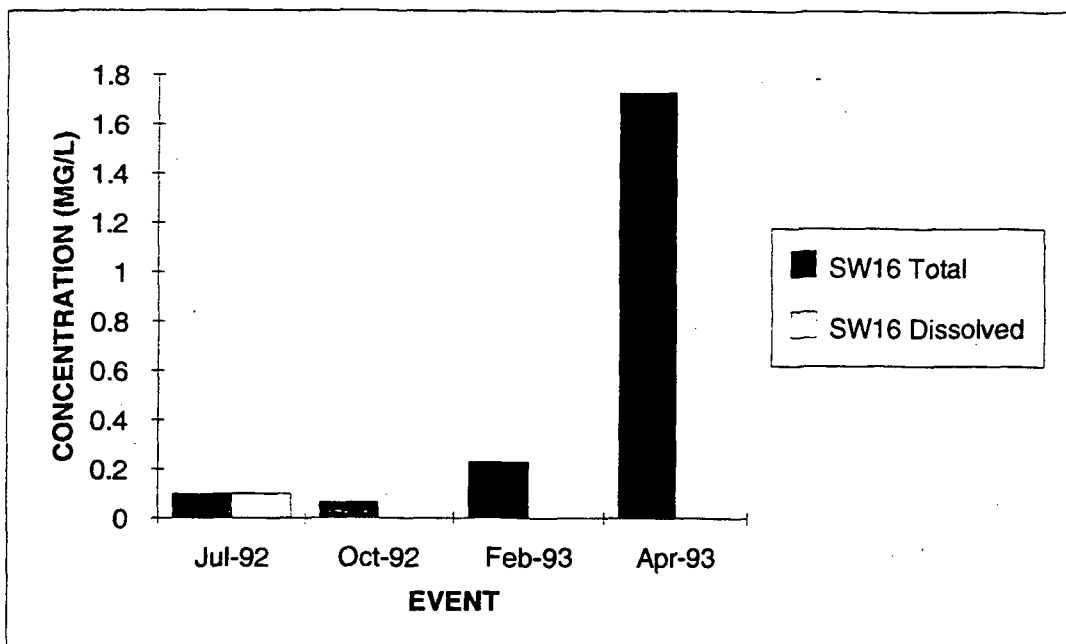
JOB No.

21372

DRAWING NO.

FIGURE 4.5-5

REV.



Note:
Concentrations are not denoted in this figure
for samples in which results were reported
as not detected.

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Aluminum Concentrations for
River Stations SW25 and SW16



JOB No.

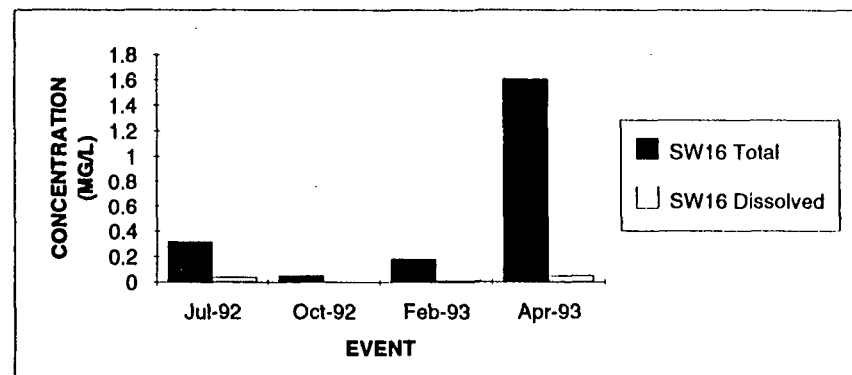
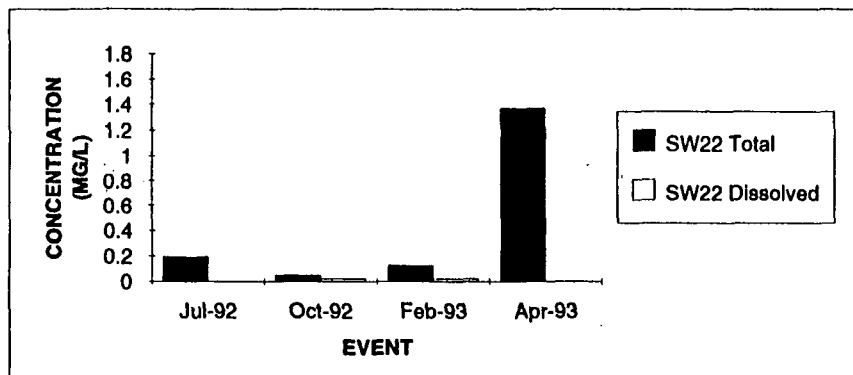
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DRAWING NO.

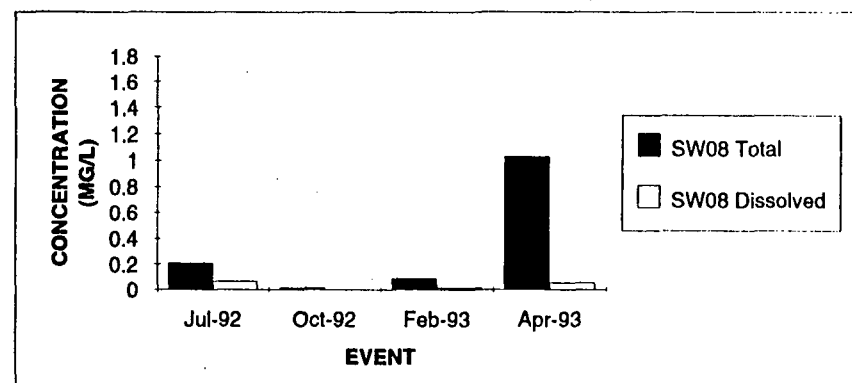
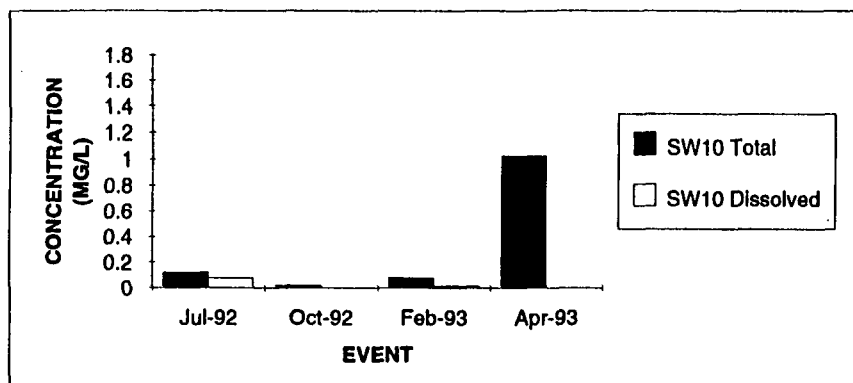
FIGURE 4.5-6

REV.

Losing Reach



Gaining Reach



Note: Concentrations are not denoted in this figure for samples in which results were reported as not detected.

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Iron Concentrations in River Samples



JOB No.

21372

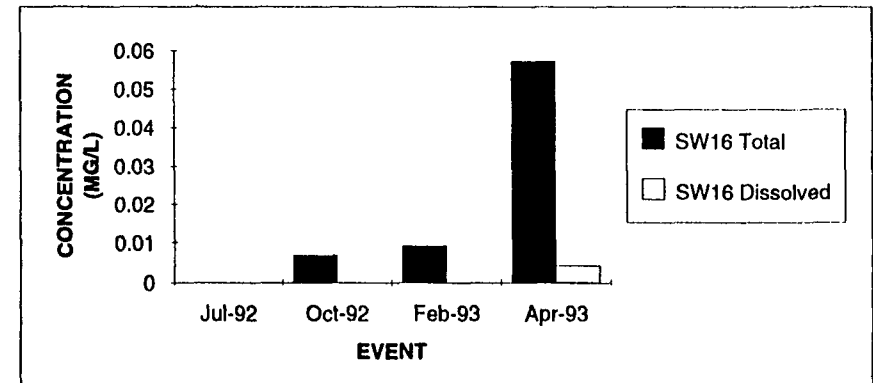
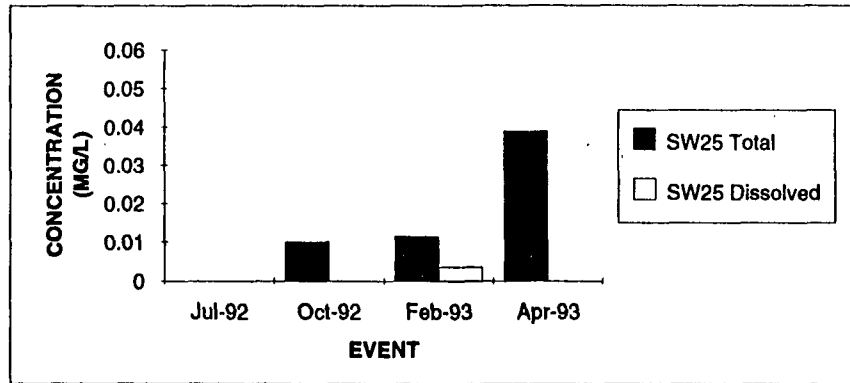
DRAWING NO.

FIGURE 4.5-7

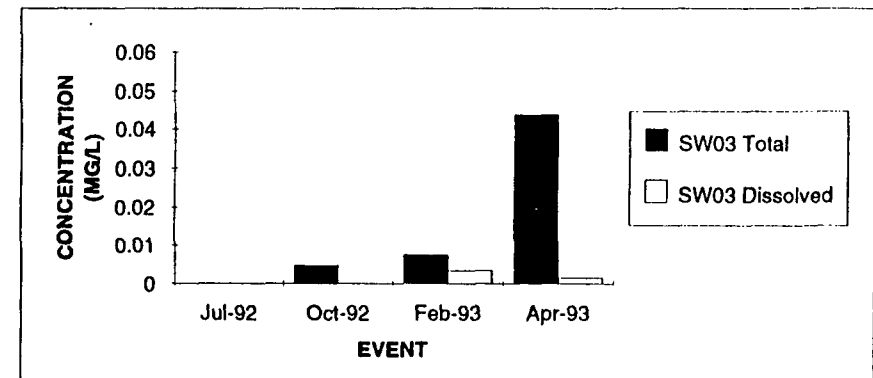
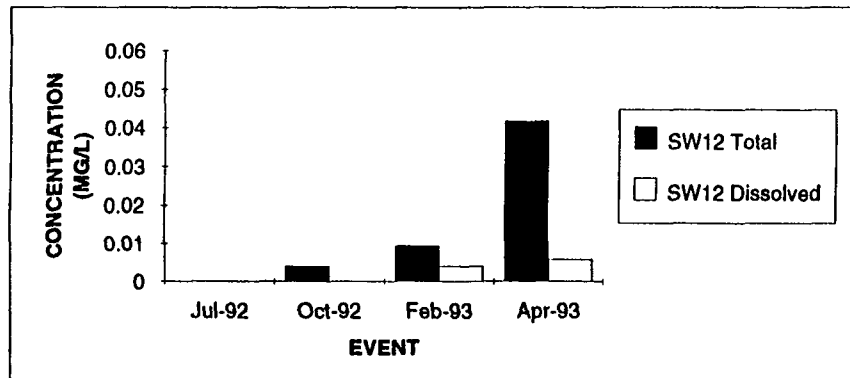
REV.

0

Losing Reach



Gaining Reach



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Manganese Concentrations in
River Samples



JOB No.

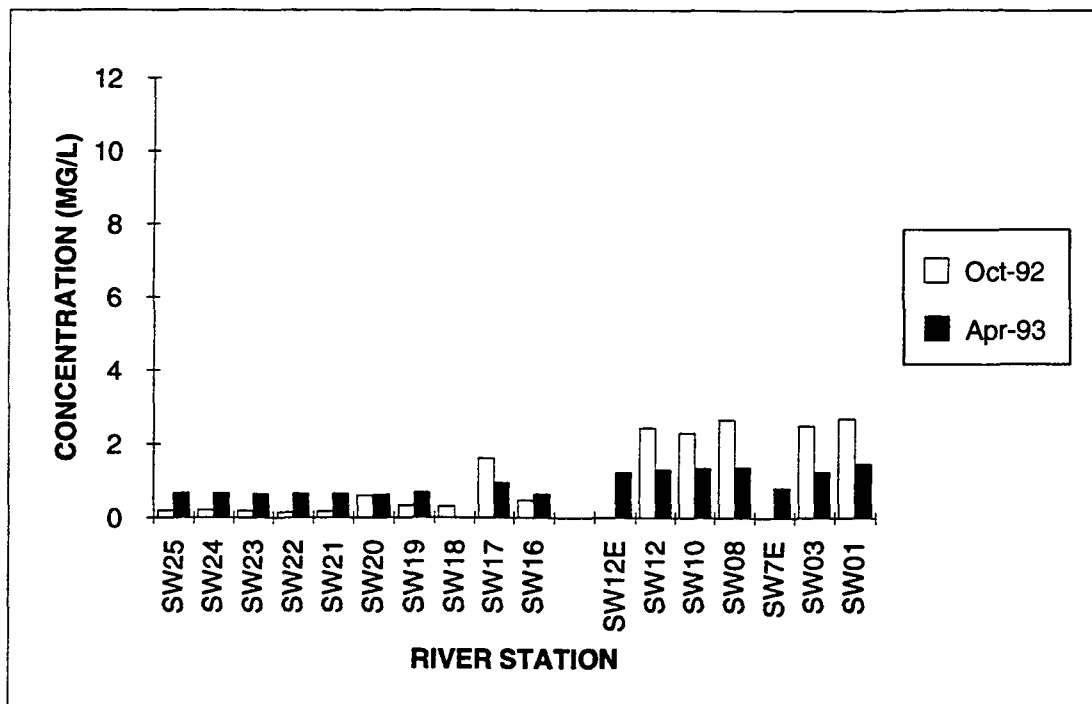
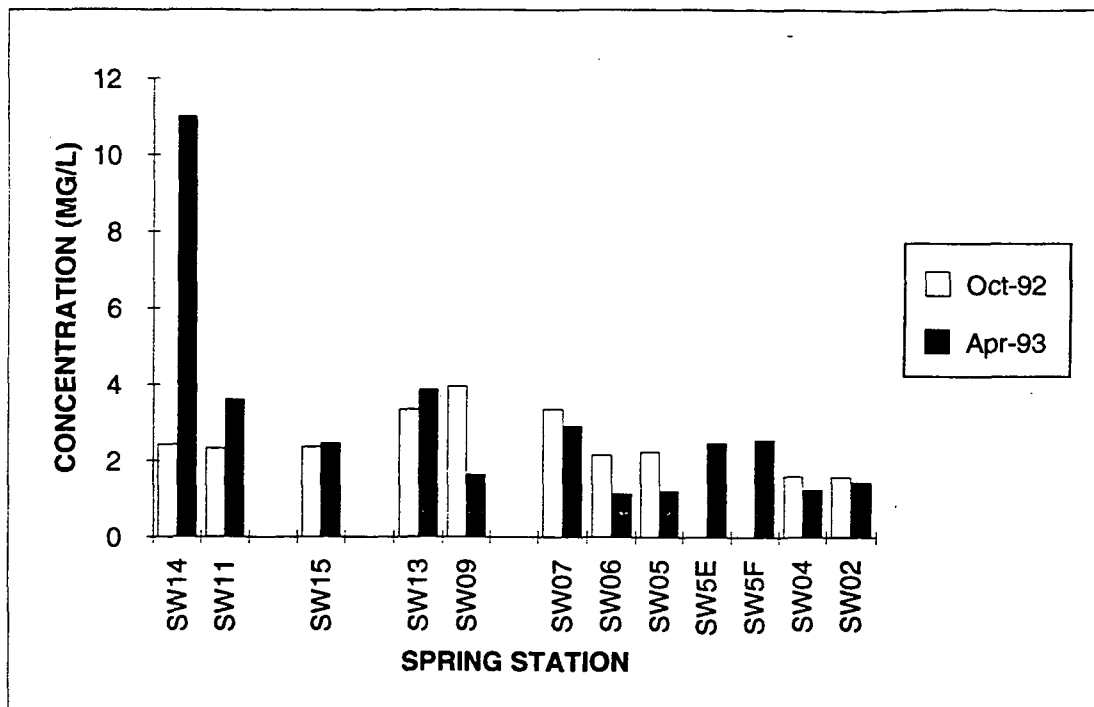
21372

DRAWING NO.

FIGURE 4.5-8,

REV.

0



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Nitrate in Springs and River



JOB No.

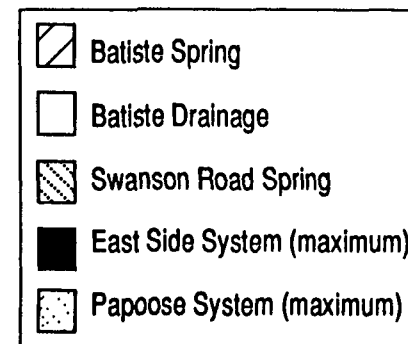
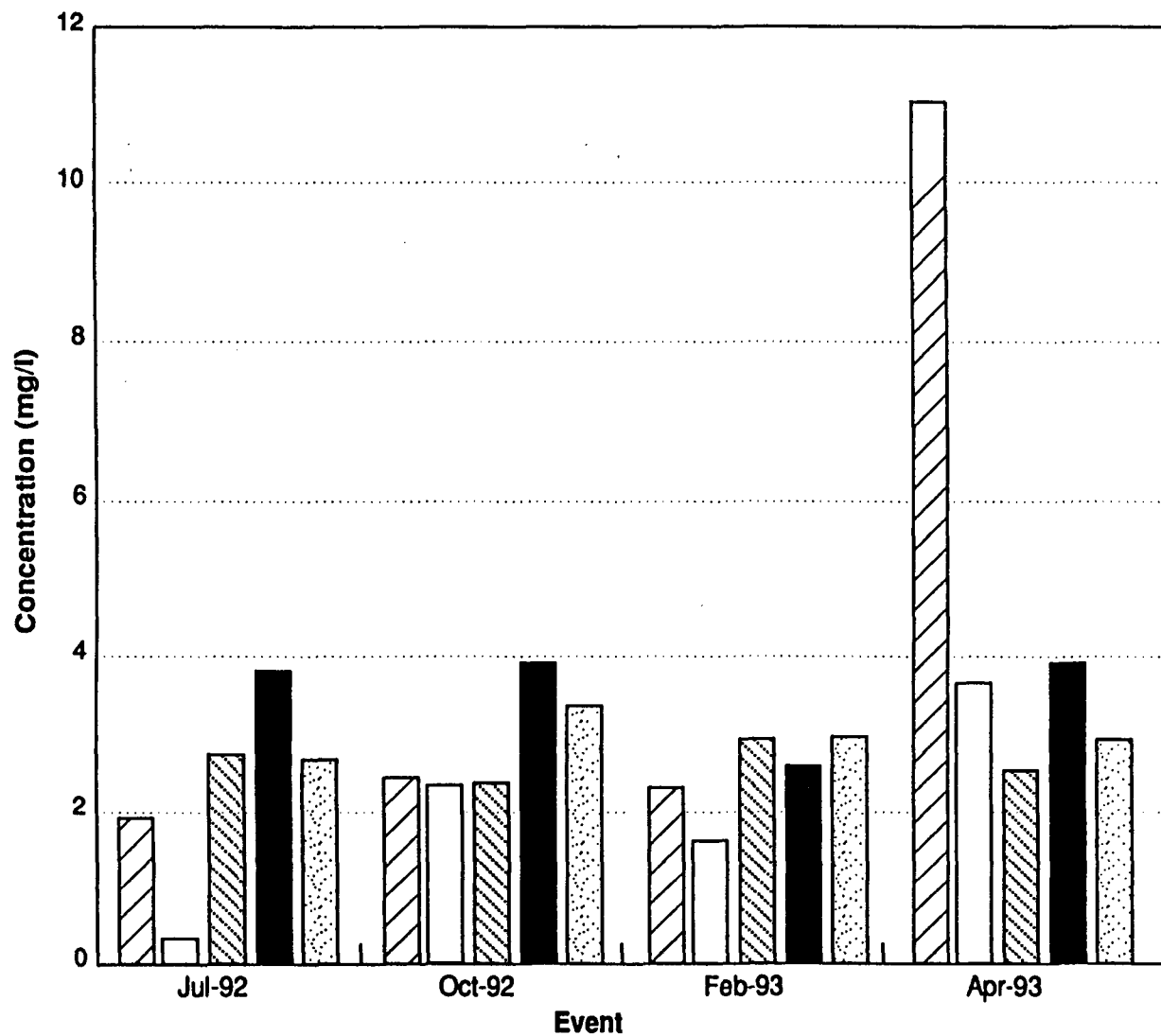
21372

DRAWING NO.

FIGURE 4.5-9

REV.

0



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Nitrate Concentrations for
Springs over Four Quarters



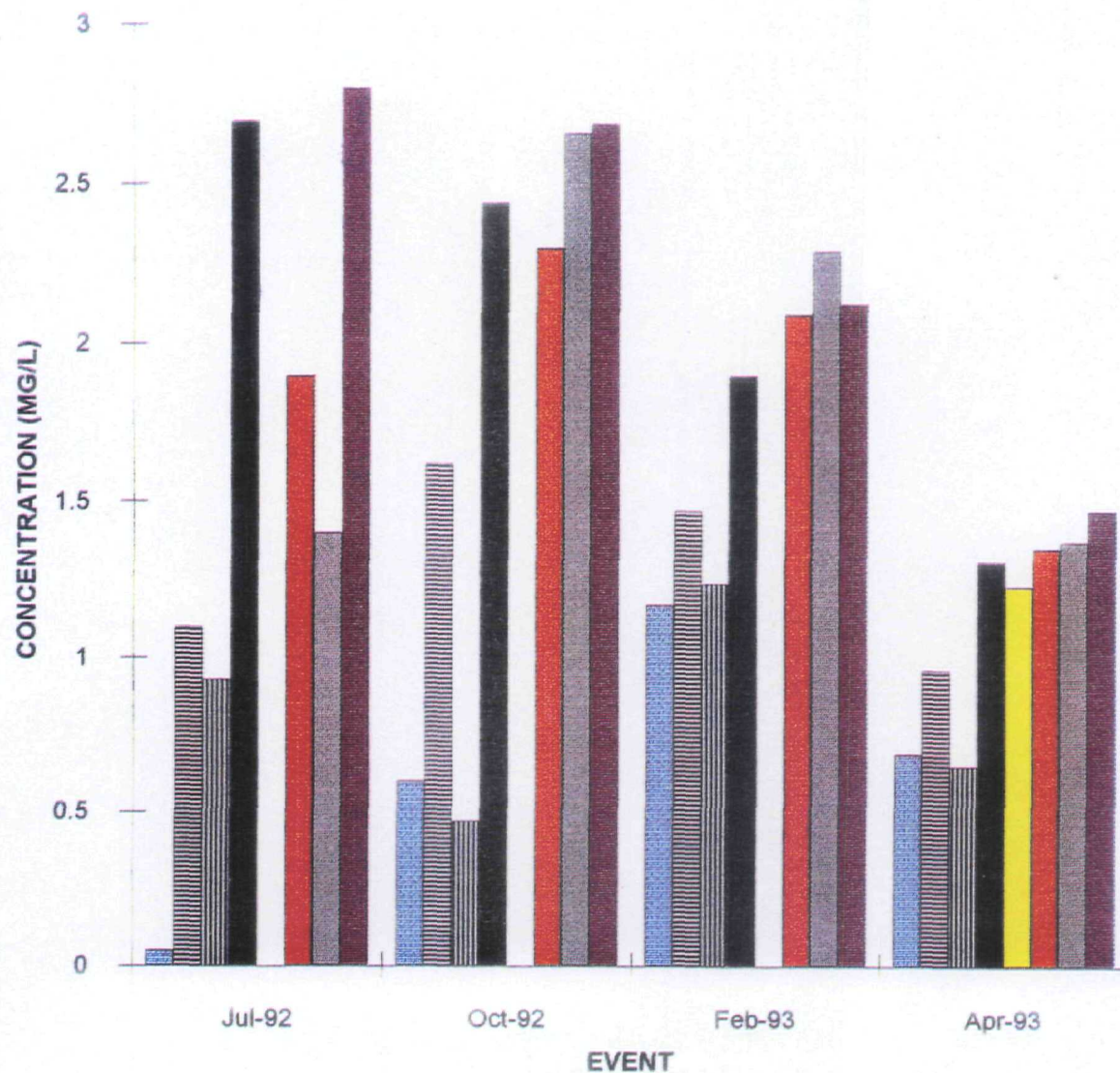
JOB No.

21372




DRAWING NO.

FIGURE 4.5-10






REV.



Losing Reach:

-  SW25 to SW18 (maximum)
-  SW17 (below FMC Outfall)
-  SW16

Gaining Reach:

-  SW12 (below STP discharge)
-  SW12E
-  SW10
-  SW08
-  SW7E to SW01 (maximum)

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Nitrate Concentrations for
River Stations over Four Quarters



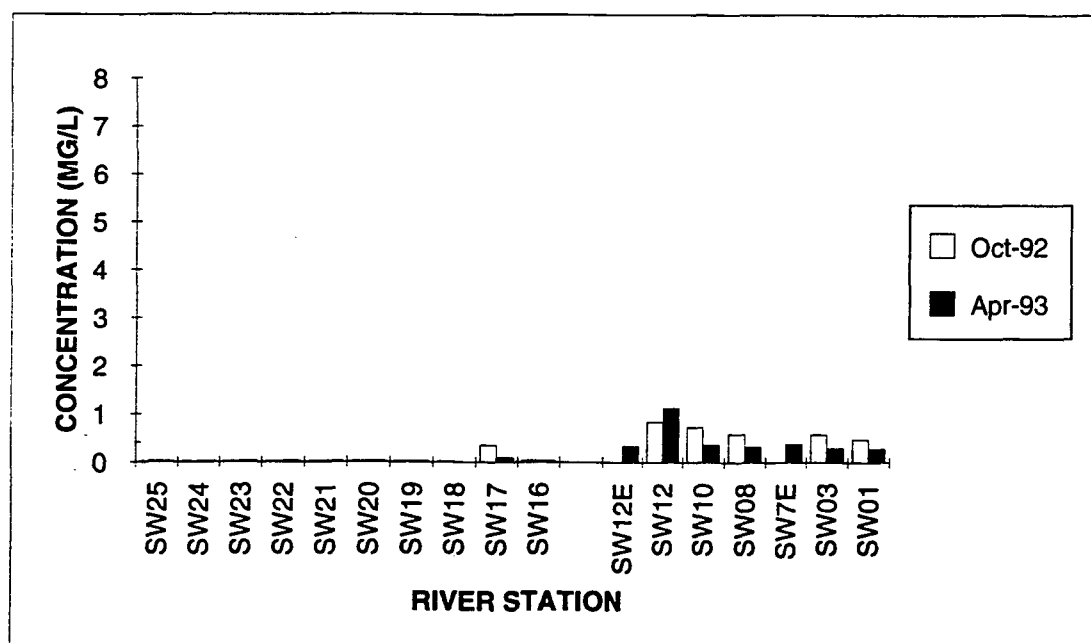
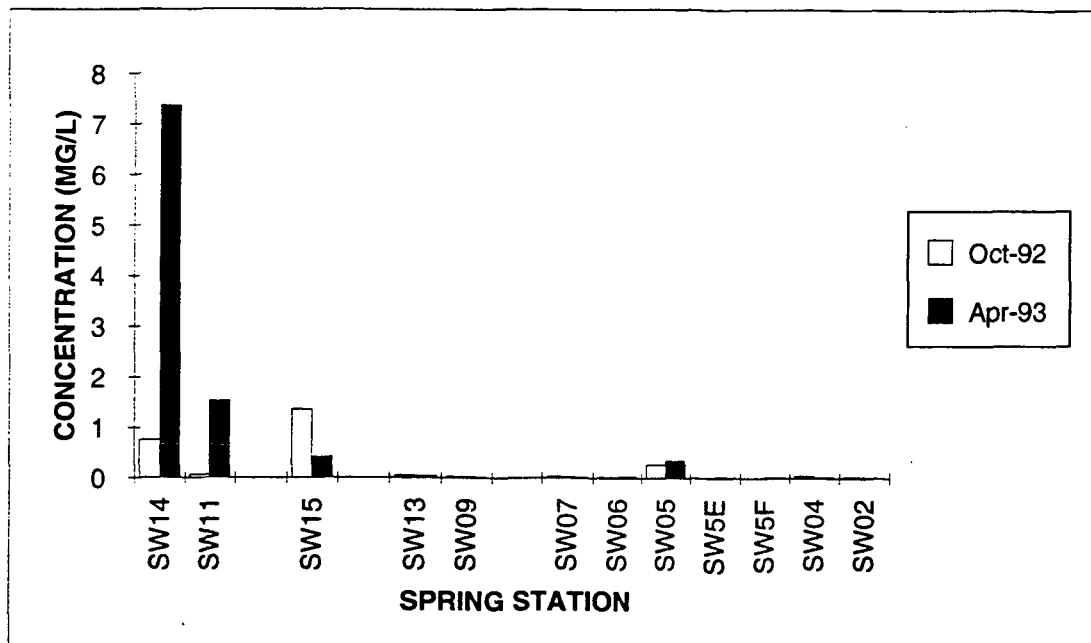
JOB No.

21372

DRAWING No.

FIGURE 4.5-11

REV.



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

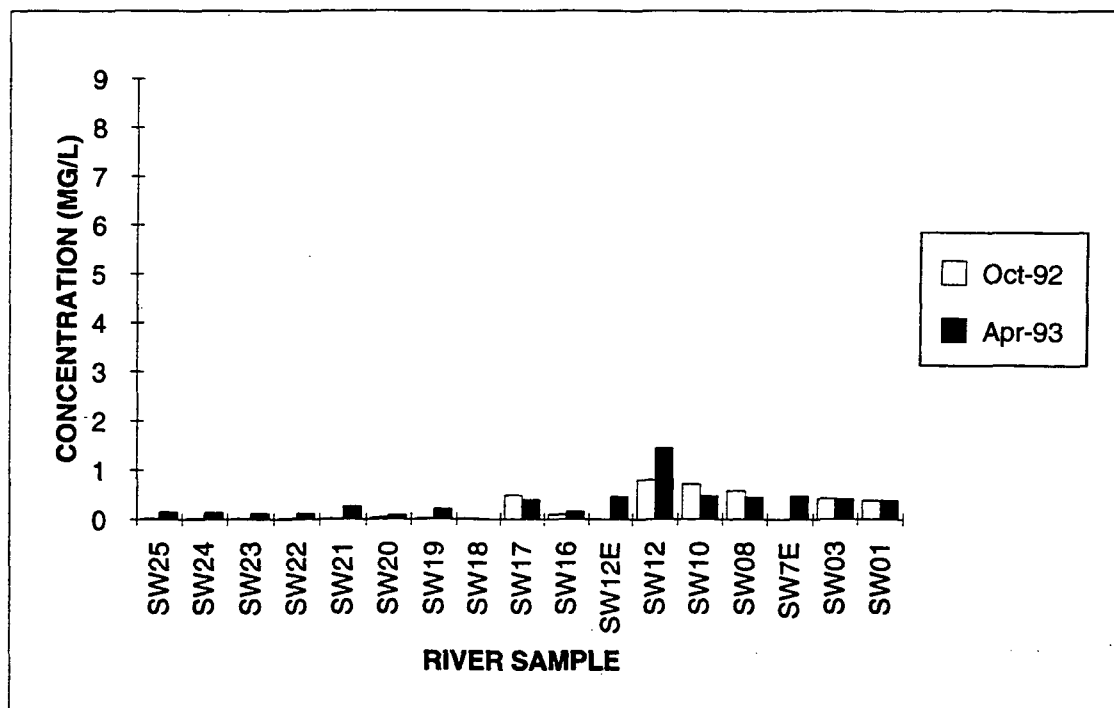
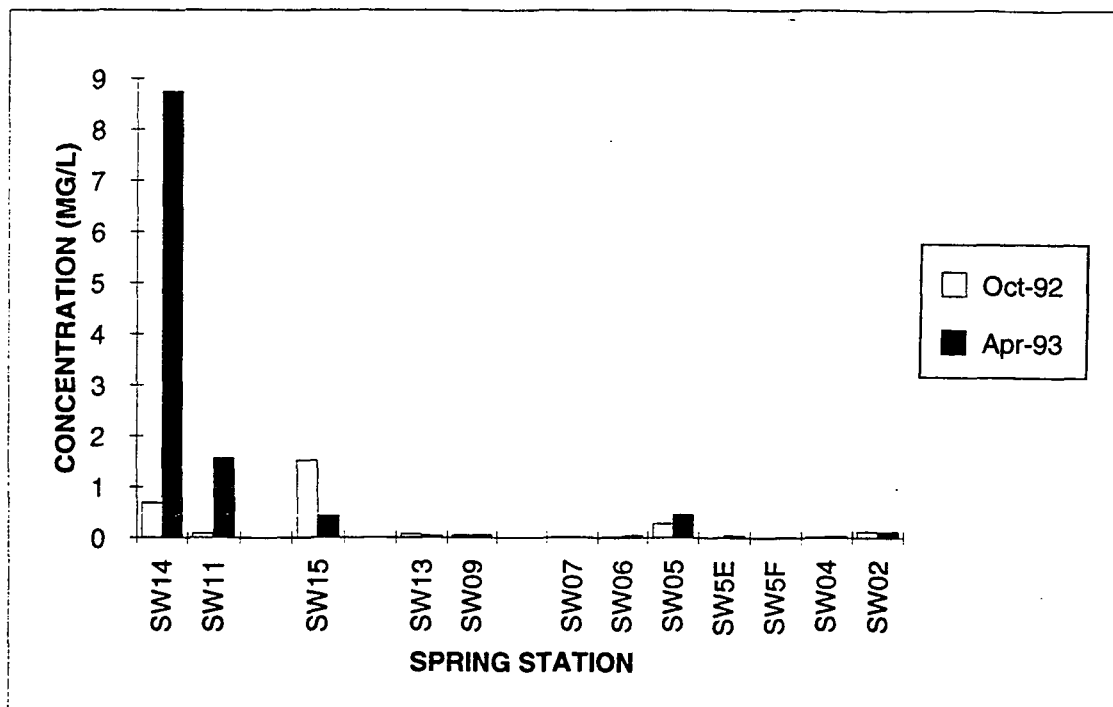
Orthophosphate in
Springs and River



JOB No.
21372

DRAWING NO.
FIGURE 4.5-12

REV.
0



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Total Phosphorous in
Springs and River



JOB No.

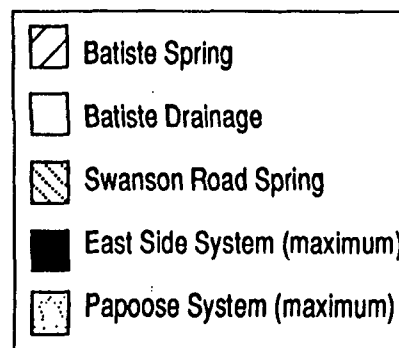
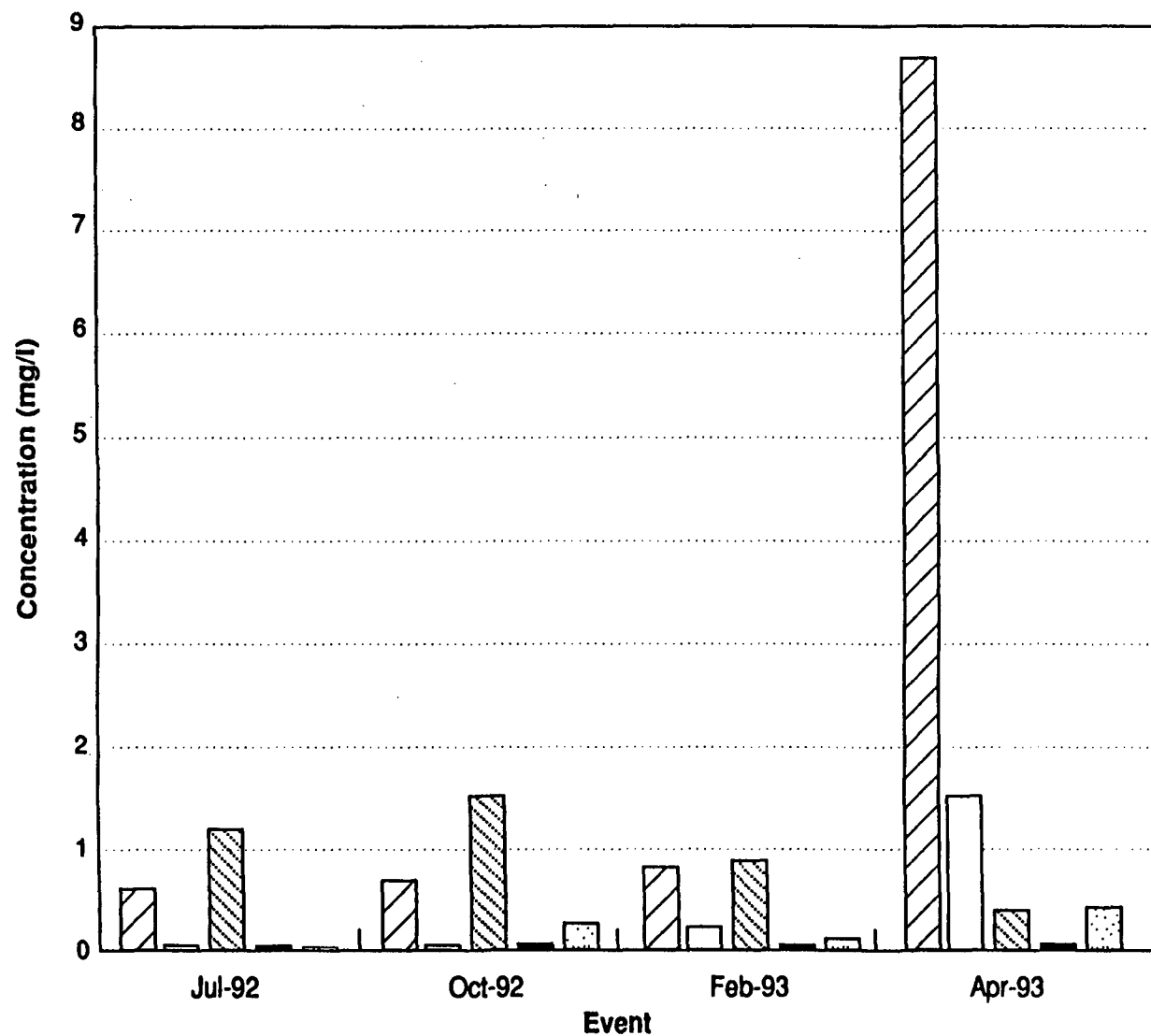
21372

DRAWING NO.

FIGURE 4.5 -13

REV.

0



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Total Phosphorus Concentrations for
Springs over Four Quarters



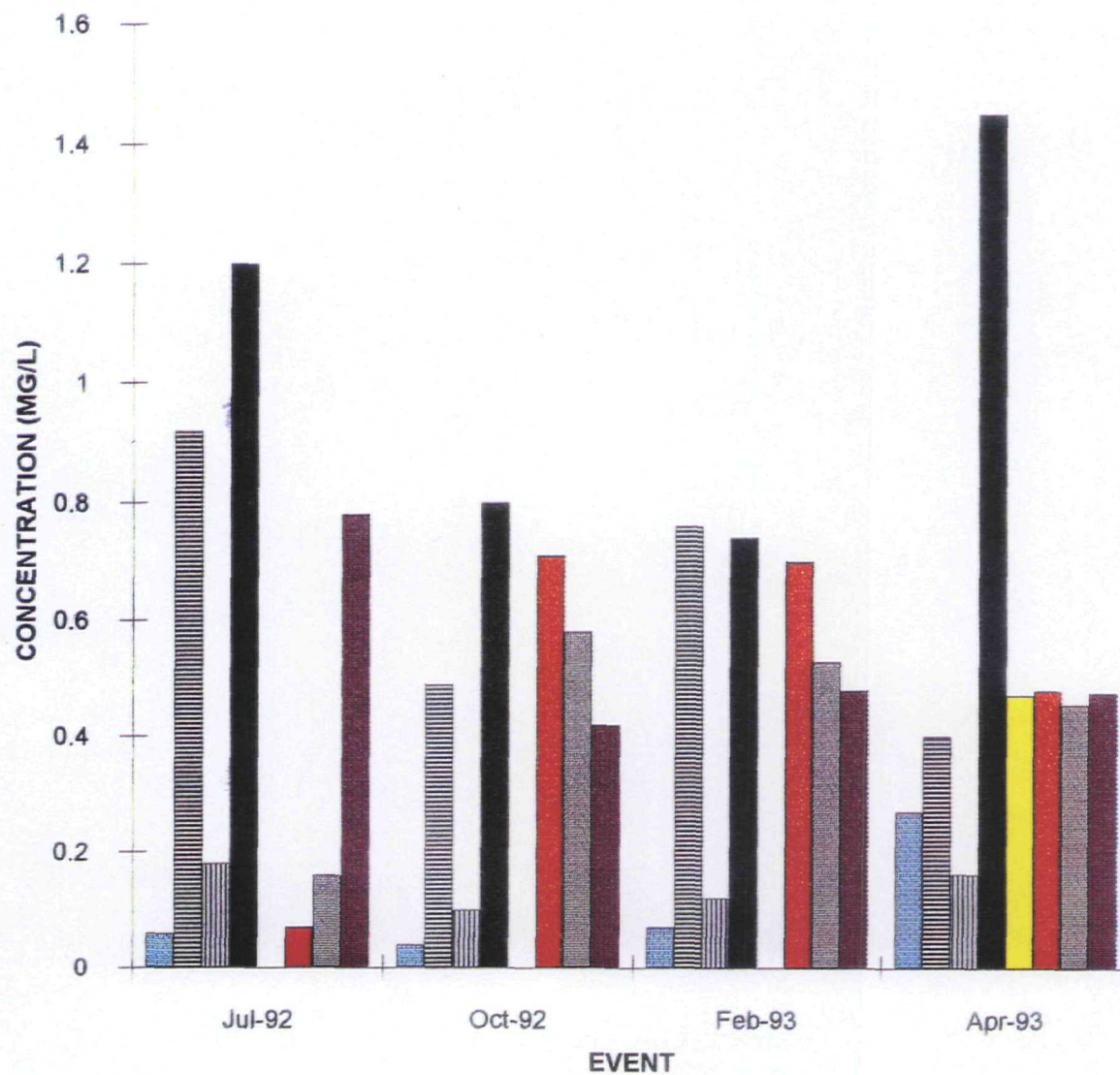
JOB No.

21372

DRAWING NO.

FIGURE 4.5-14

REV.



Losing Reach:

- SW25 to SW18 (maximum)
- SW17 (below FMC Outfall)
- SW16

Gaining Reach:

- SW12 (below STP discharge)
- SW12E
- SW10
- SW08
- SW7E to SW01 (maximum)

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Total Phosphorus Concentrations for
River Stations over Four Quarters



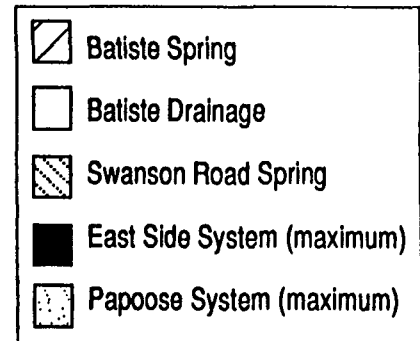
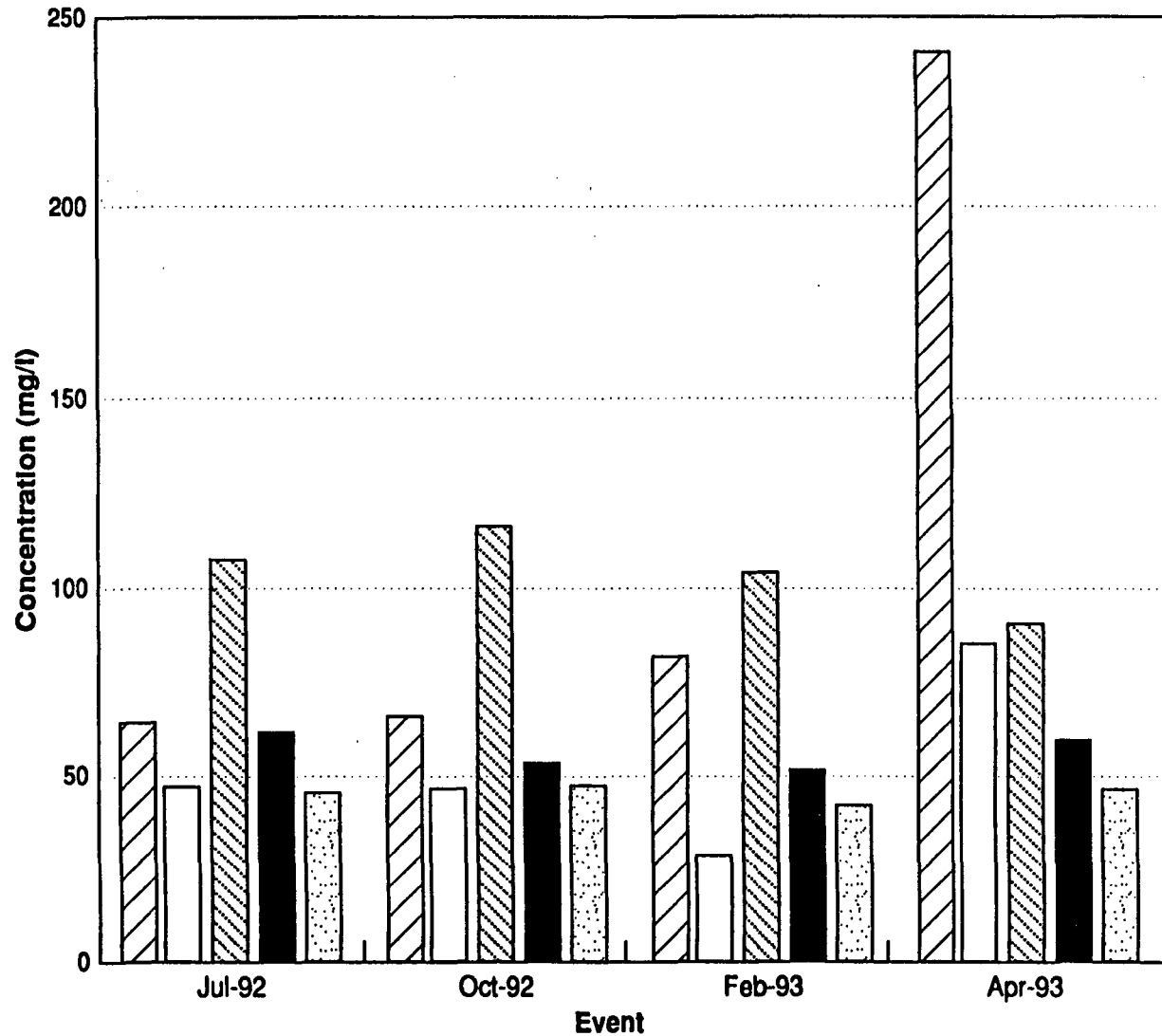
JOB No.

21372

DRAWING NO.

FIGURE 4-5-15

REV.



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Sulfate Concentrations for
Springs over Four Quarters



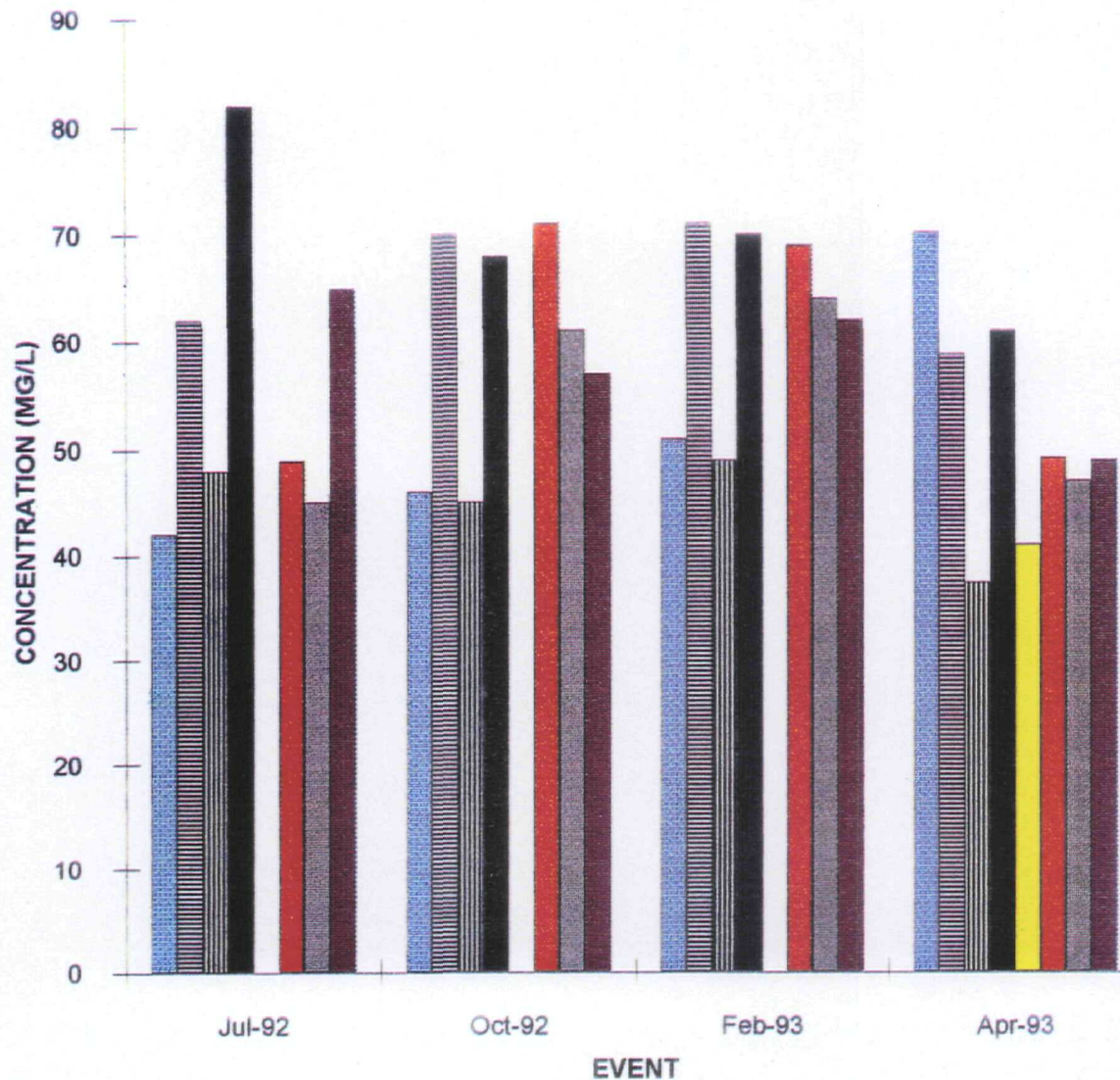
JOB No.

21372

DRAWING NO.

FIGURE 4.5-16

REV.



Losing Reach:

- SW25 to SW18 (maximum)
- SW17 (below FMC Outfall)
- SW16

Gaining Reach:

- SW12 (below STP discharge)
- SW12E
- SW10
- SW08
- SW7E to SW01 (maximum)

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Sulfate Concentrations for
River Stations over Four Quarters



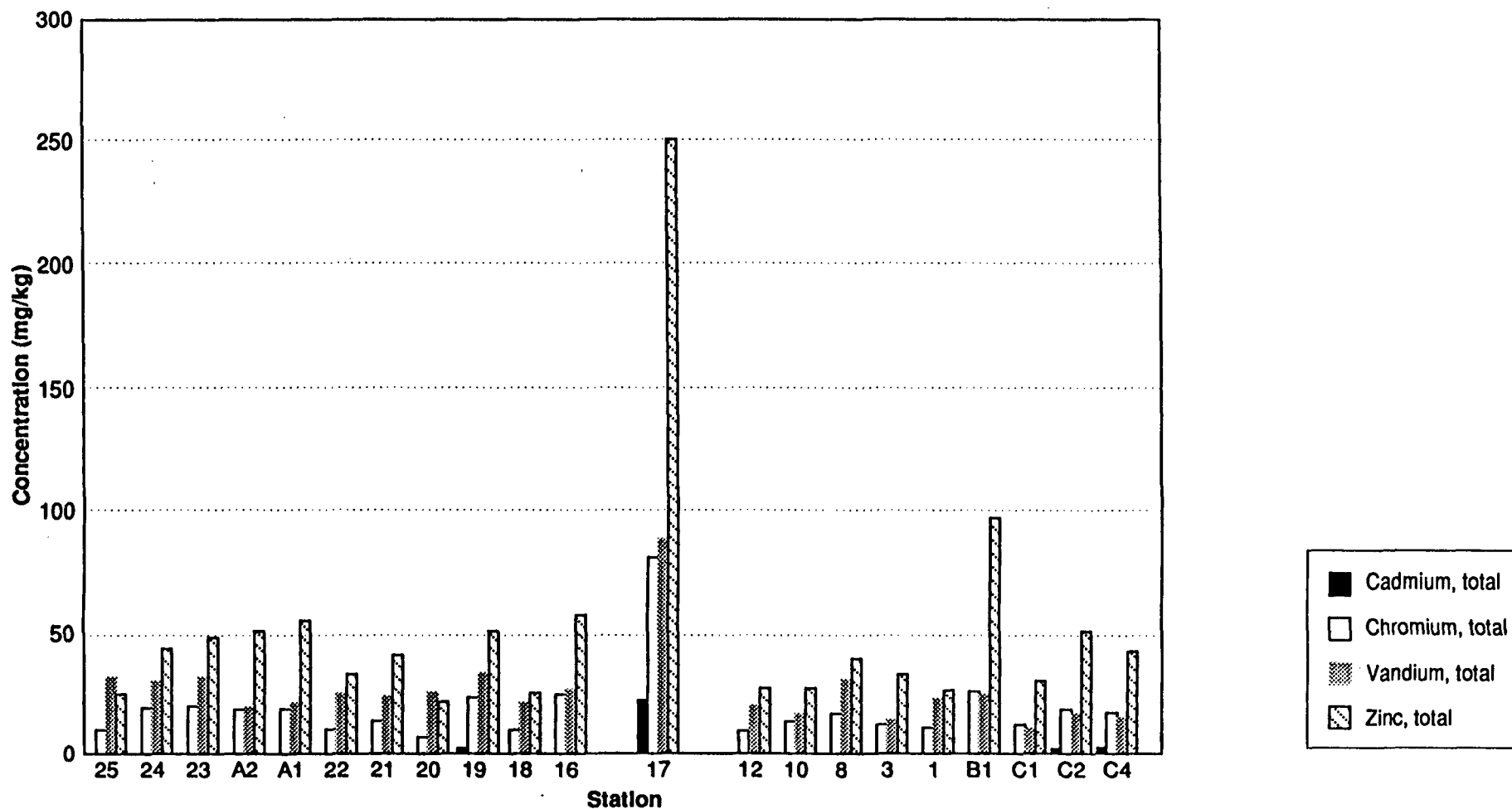
JOB No.

21372

DRAWING NO.

FIGURE 4.5-17

REV.



Losing

Gaining

BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Concentrations of Indicator Metals in
Sediments for River Sampling Stations



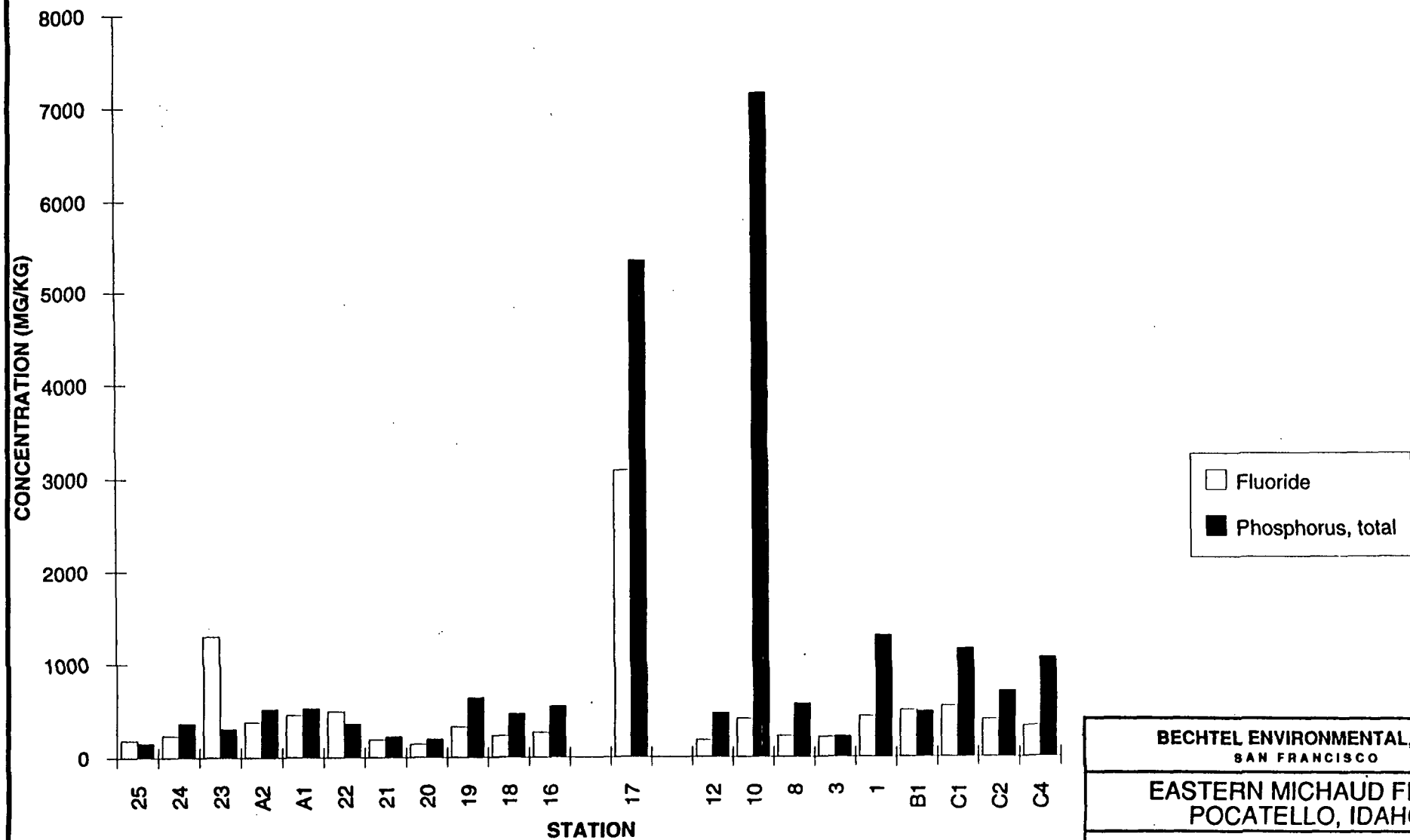
JOB No.


21372

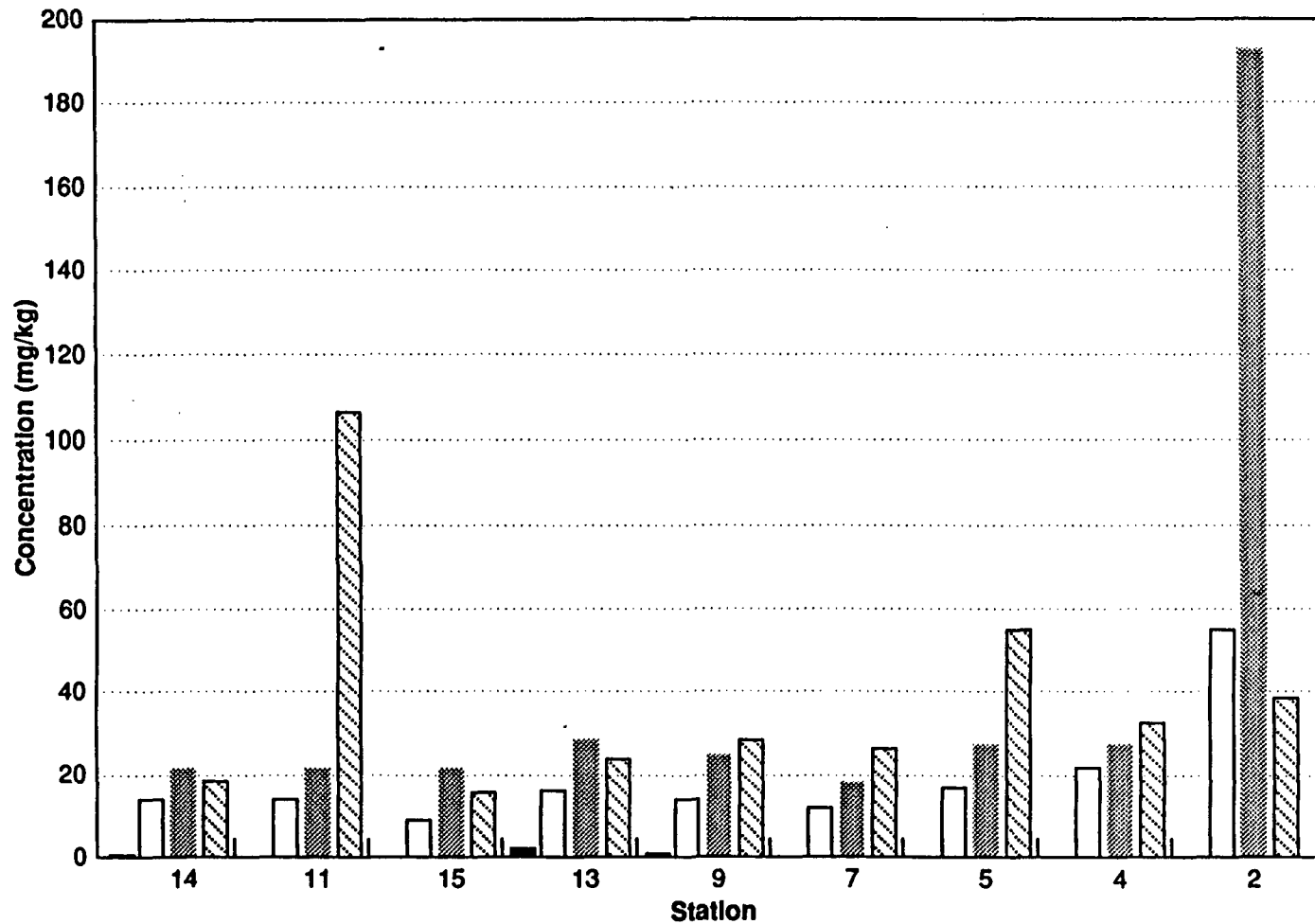
DRAWING NO.

FIGURE 4.5-18

REV.



BECHTEL ENVIRONMENTAL, INC. SAN FRANCISCO		
EASTERN MICHAUD FLATS POCATELLO, IDAHO		
Concentrations of Total Phosphorus and Fluoride in River Sediments		
	JOB No.	DRAWING NO.
	21372	FIGURE 4.5.-19
		REV.



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Concentrations of Indicator Metals
in Spring Sediments



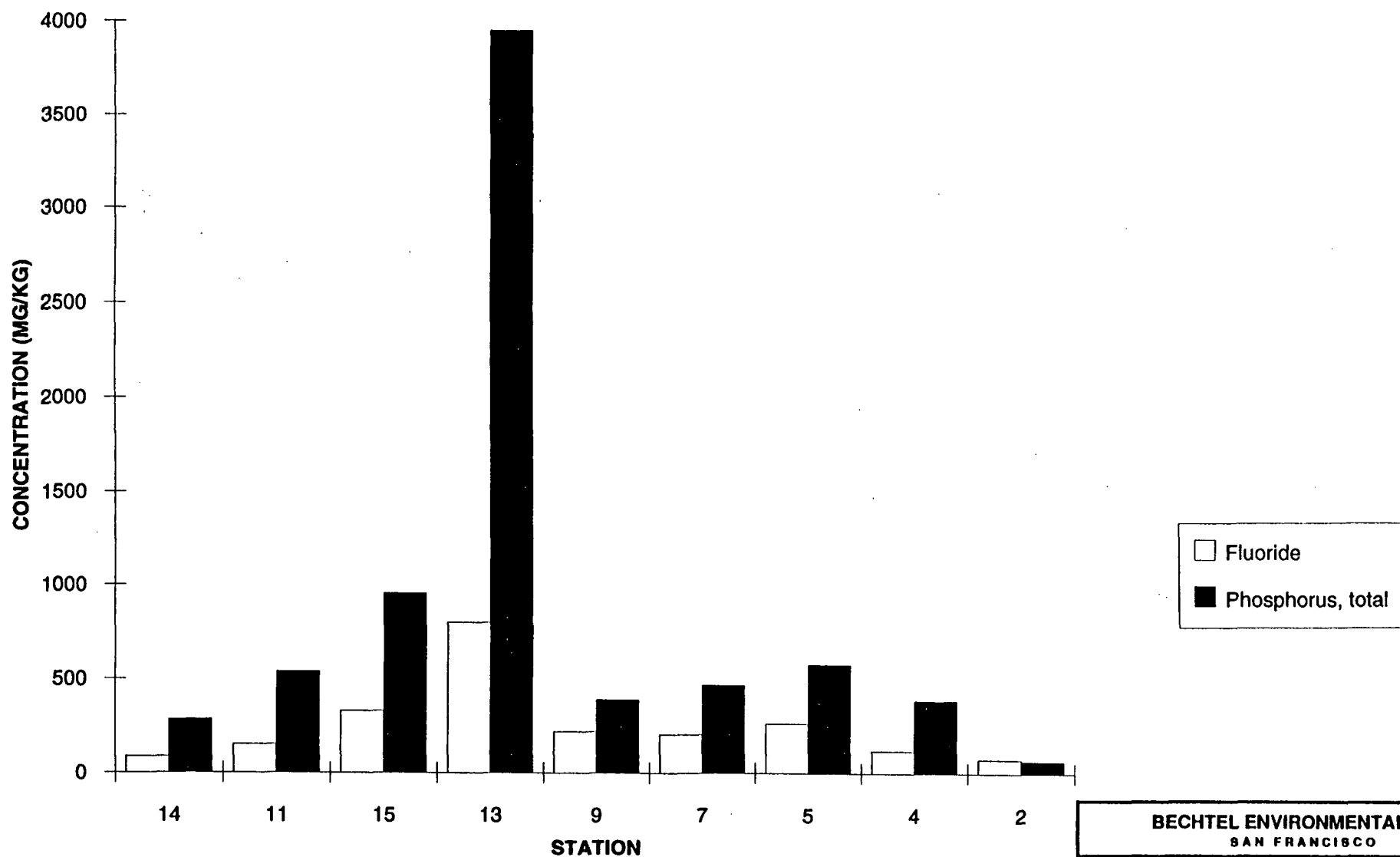
JOB No.

21372

DRAWING NO.

FIGURE 4.5-20

REV.



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Concentrations of Total Phosphorus
and Fluoride in Spring Sediments



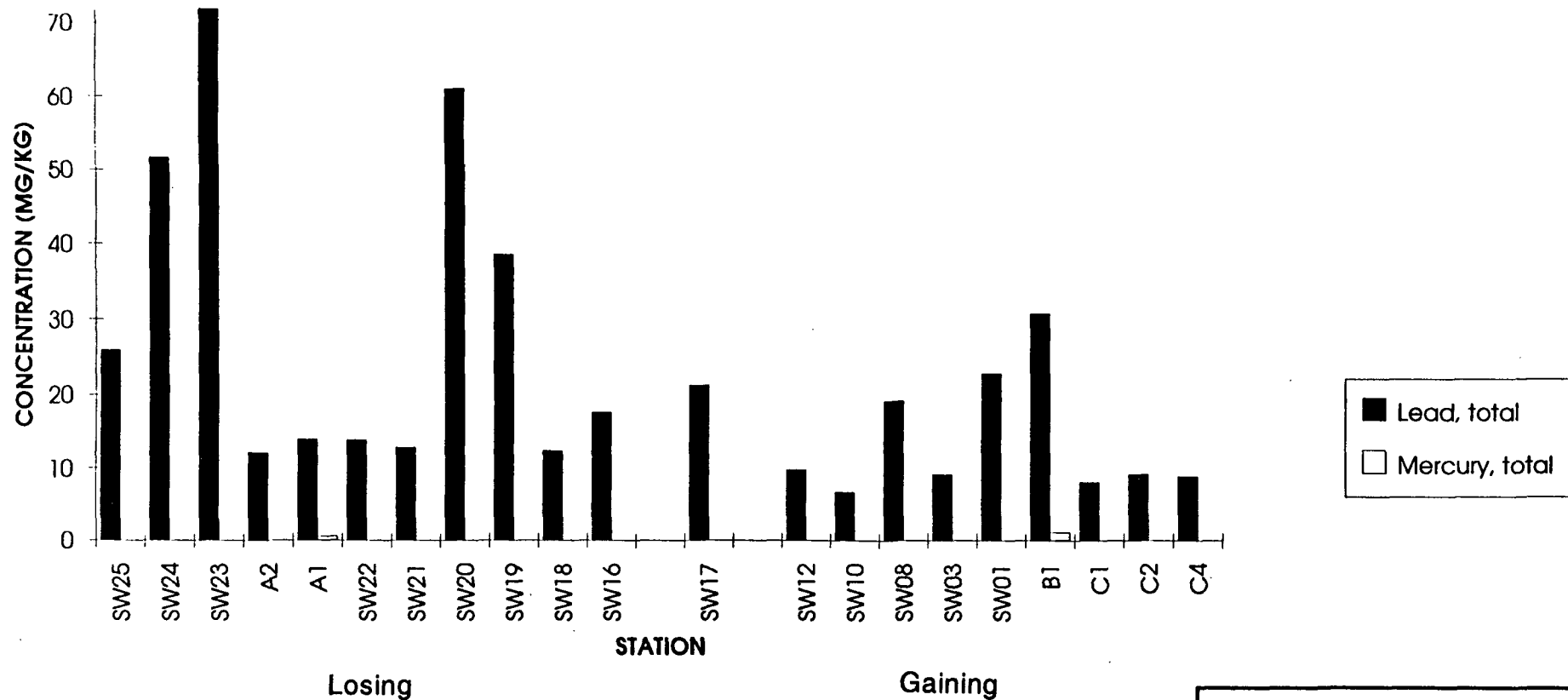
JOB No.

21372

DRAWING NO.

FIGURE 4.5-21

REV.



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Concentrations of Lead and Mercury in
Sediments for River Sampling Stations



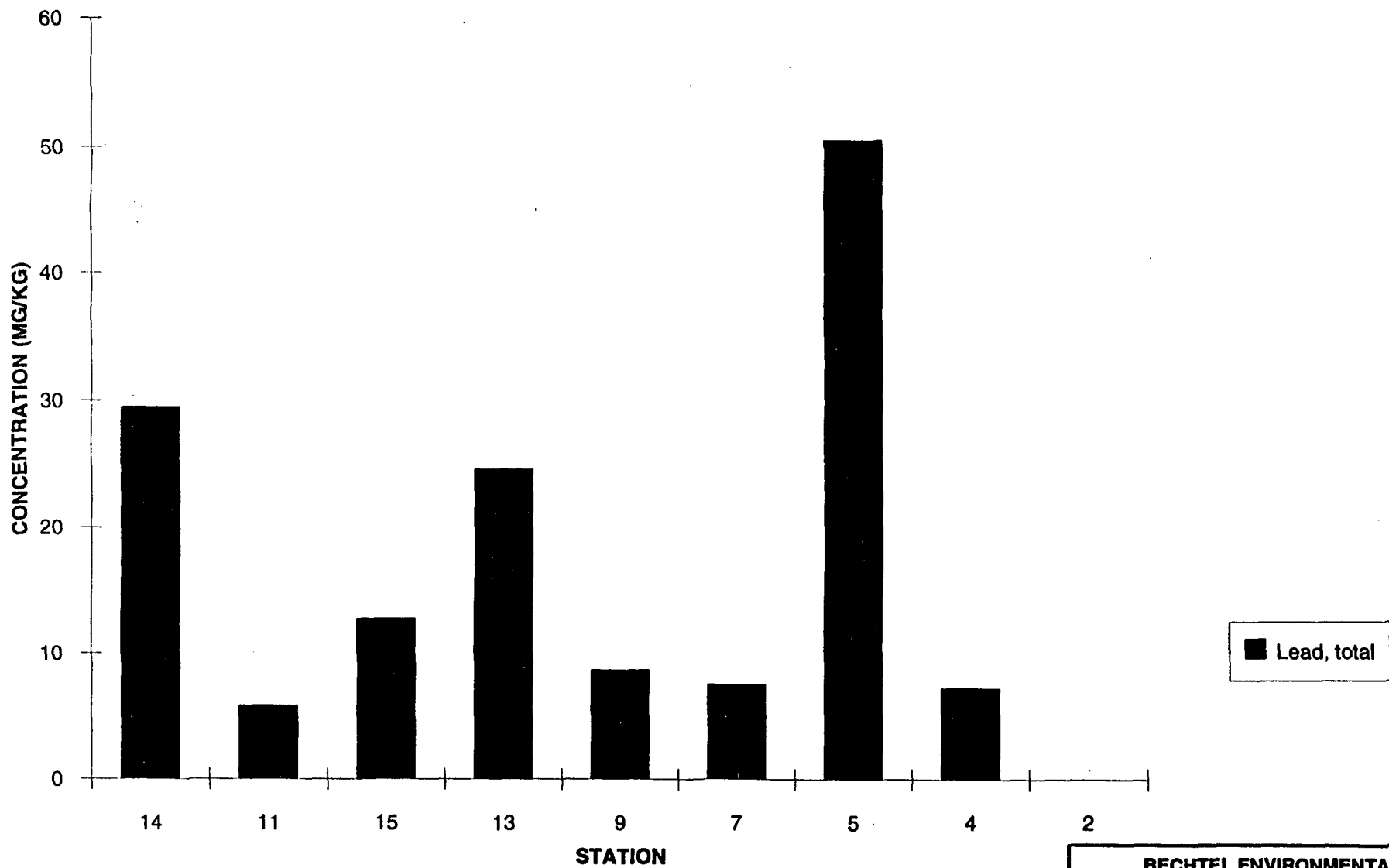
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21372

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FIGURE 4.5-22

REV.



BECHTEL ENVIRONMENTAL, INC.
SAN FRANCISCO

EASTERN MICHAUD FLATS
POCATELLO, IDAHO

Concentrations of Lead in
Spring Sediments



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FIGURE 4.5-23

REV.